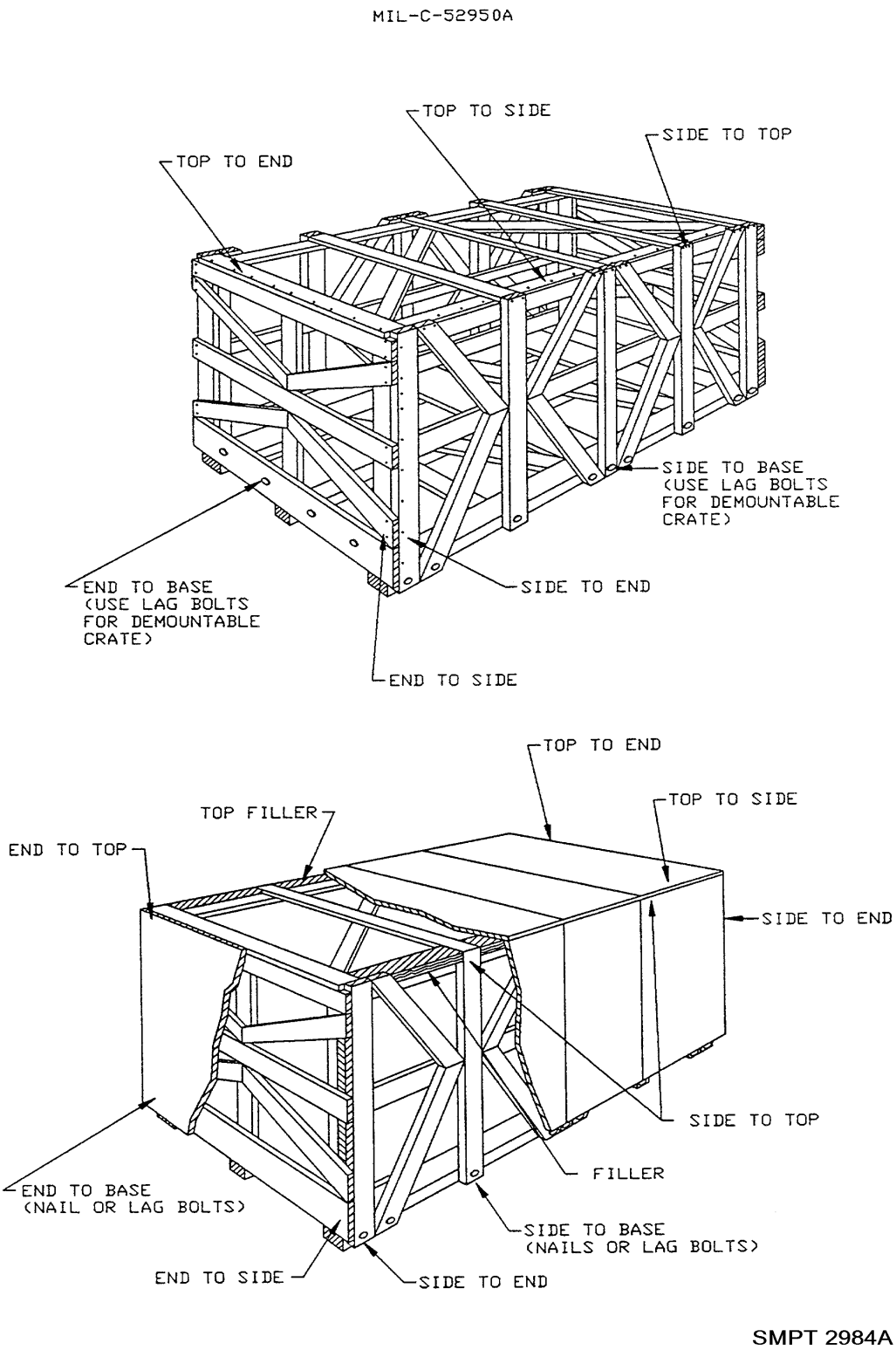


Figure 6-38. Type V, style B crate (MIL-C-52950), open and covered.

To prevent splitting, place one carriage bolt crosswise to two to three inches back from each end of the skid (fig 6-39). When necessary, splice and laminate skids according to the details shown on figure 6-55.

Rubbing Strip

Rubbing strips are required on all 4 X 4-inch skids and must be at least 2 inch material, approximately as wide as the skid. Bevel these members at a 45° angle and set back approximately 8 inches from the ends of the skids. Bevel the inner ends of the notches at a 45° angle. These areas will serve as sling points and for forklift entries.

Headers

The sizes of end headers and bolts are outlined as follows:

Skid size (inches)	Header size (inches)	Bolt diameter (inches)
2 X 4	2 X 4	3/8
3 X 3	3 X 3	3/8
4 X 4	4 X 4	1/2
4 X 6 (in edge)	4 X 4	1/2

Extend headers beyond the outside faces of the outer skids three-fourths of an inch to support the lower frame members of the sides.

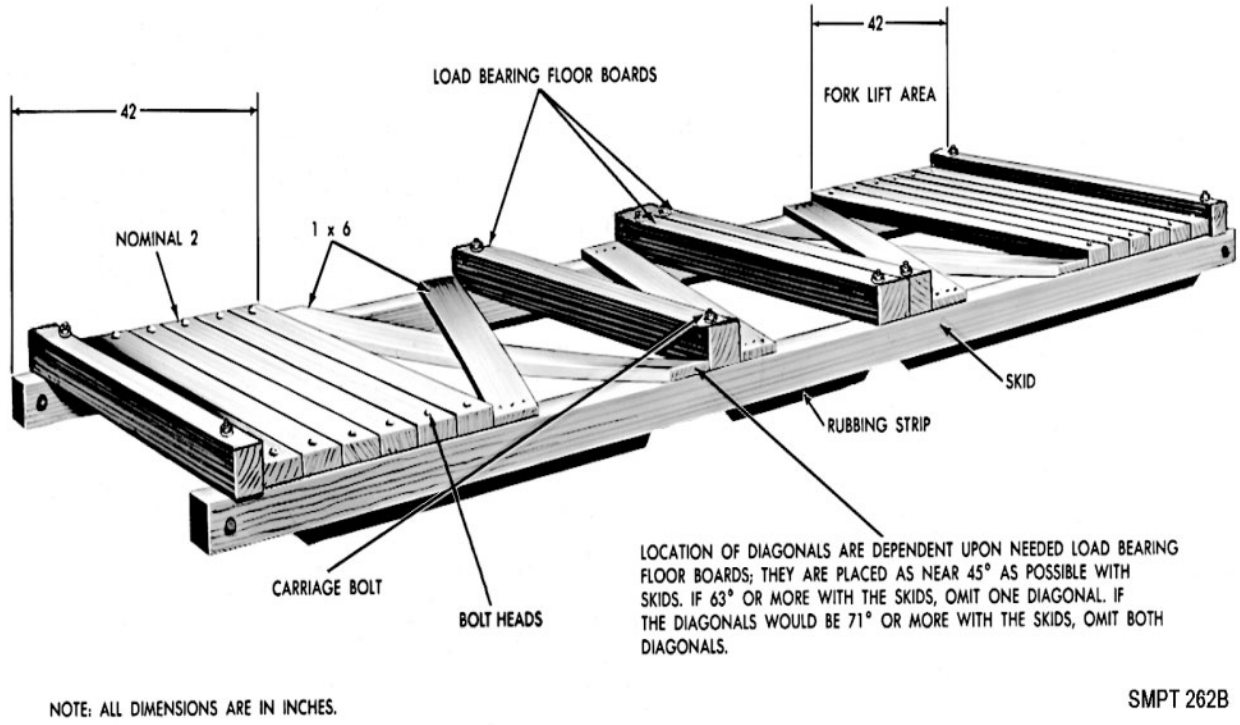


Figure 6-39. Skid base for bolted crate (MIL-C-3774).

Load Bearing Floorboards

Place load bearing floorboards where the concentrated loads. Determine the size of load bearing floorboards from table 6-4. The end floorboards of 2 inch flooring may be considered as load-bearing within limits of their within limits of their assigned values. The load-bearing members shall be placed with the ends flush with the outside faces of the skids, as shown in figure 6-39, and bolted to each skid with carriage bolts. One bolts shall be used at each skid crossing for widths not exceeding 4 inches and two bolts, for greater widths. Size of carriage bolts shall be the same as those used in the end headers.

Forklift Area

The forklift area extends over the area of 42 inches in from the ends of the skids and may consist of the following:

- Forklift headers spaced 20 to 40 inches in from each end header.
- 2-inch-thick boards extending 42 inches in from each end.
- Plywood for narrow crates.

Diagonals

1 X 6-inch diagonals are used between forklift areas and loadbearing members. The diagonals are nailed to the skids and to each other where they intersect.

Sides

The sides consist of upper, lower, and intermediate members, vertical struts, diagonals, and corner sheathing.

Side Panels

The design of the side panel is illustrated in figure 6-40. The number of diagonals will depend upon the size of the crate.

Member Selection

The sizes of the upper, lower, and intermediate longitudinal members are based upon the gross weight and length of the crate as stated in table 6-13.

Table 6-12. Skid Sizes of Bolted MIL-C-3774 Crates

Maximum Net Load	Maximum length of crate	Size of skids
Pounds	*Feet*	*Inches*
2,000	12	3 x 4
4,000	[1]40	4 x 4
5,000	20	4 x 4
10,000	16	4 x 4
5,000	32	4 x 6 (on edge)
16,000	20	4 x 4 (on edge)

[1] For lengths over 32 feet, crate heights shall be no less than 8 feet.

Table 6-13. Frame-member Sizes (Sides of Bolted Crates)

Limits		Size of members		
Length	Net load	Upper frame members	Lower frame members	Horizontal brace
Feet	*Pounds*	*Inches*	*Inches*	*Inches*
[2]12	500	[3]5/8 x 4	[3]5/8 x 4	[3]5/8 x 4
10	2,000	1 x 4	1 x 4	1 x 4
16	4,000	1 x 6	1 x 6	1 x 6
12	8,000	1 x 6	1 x 6	1 x 6
[4]40	4,000	2 x 4	2 x 6	2 x 4
16	10,000	2 x 4	2 x 6	2 x 4
20	10,000	2 x 6	2 x 8	2 x 4
20	16,000	2 x 8	2 x 10	2 x 8

NOTES: 1/ For crates of 48 inches and over
2/ Size limits of crates. In addition to the 12 foot length and 500 pound gross weight limit, this crate having 5/8 inch members shall be limited to 4 foot widths and 6 foot heights maximum.
3/ Actual thickness of members equals 5/8 inch.
4/ Crates over 32 feet in length shall be not less than 8 feet in height. Open bolted crates cannot be fabricated in lengths over 32 feet if the height is less than 8 feet. Long crates less than 8 feet high shall be fabricated in accordance with the requirements of MIL-C-104.

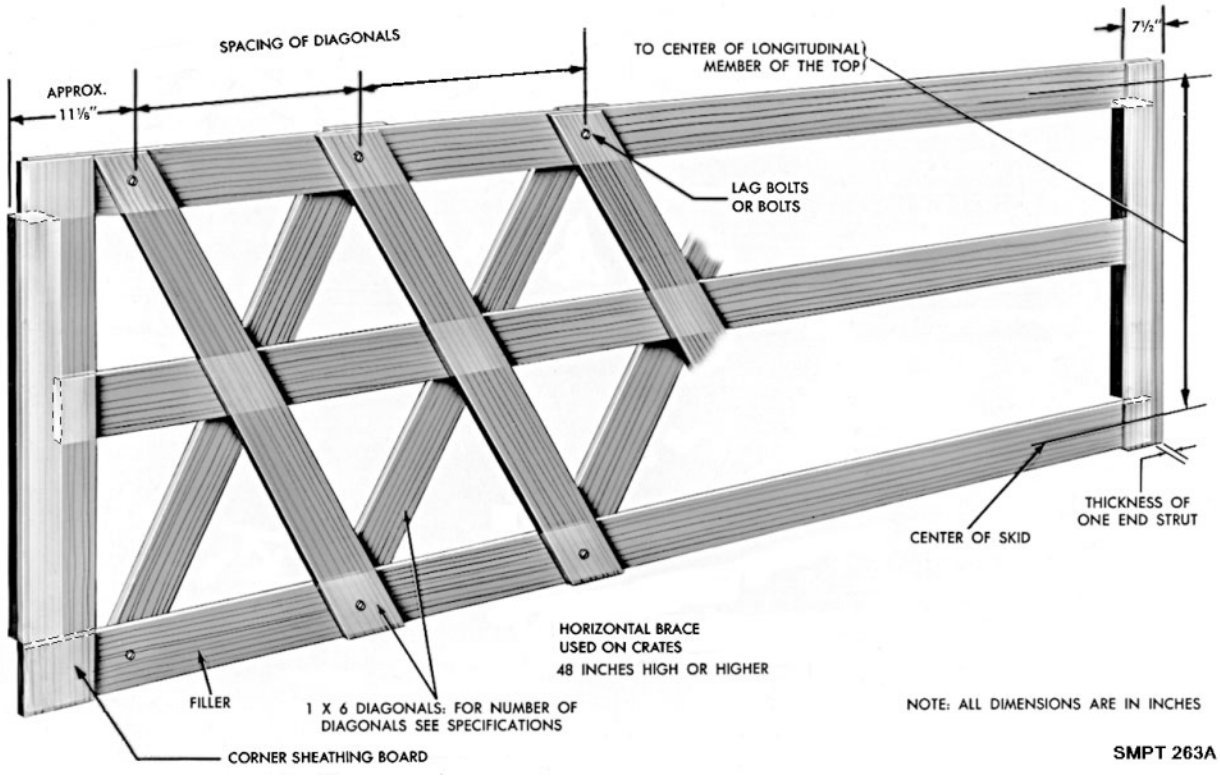


Figure 6-40. Side for bolted crate (MIL-C-3774).

Diagonals

Use 5/8 X 6 inch diagonals for crates not exceeding 12 feet in length, 4 feet in width and 6 feet in height, with a maximum net load of 500 pounds. Use 1 X 8 inch for crates exceeding 32 feet in length and 12 feet in height. Use 1 X 6-inch for all other conditions. See table 6-14 for the spacing of the diagonals. One-half of the diagonals shall be nailed to the outside of the longitudinal frame members and the other half shall be nailed to the inside of the same members, sloped in the opposite direction. The points of fastening of the diagonals, except at the end ones, to the longitudinal members shall be the same for inside and outside diagonals to permit the same lag bolts or bolts to pass through both diagonals. At the ends of the upper and lower frame members where no diagonal is present on the inside surface of the member, a filler block 12 inches long, the same thickness as one diagonal and the same width as the frame member, shall be used to provide continuous bearing. The number of diagonals is determined by the spacing of the diagonals.

Both inner and outer diagonals shall be nailed to each 2-inch horizontal member with sevenpenny nails in patterns as shown on figure 6-50.

The outer diagonals shall be nailed to each 1-inch horizontal member with six nails, three driven from each side, and clinched.

The inner diagonals shall be nailed to each horizontal member with sevenpenny nails as shown on figure 6-40. When 5/8-inch frame members are used, the nail sizes shall be reduced as required.

Vertical Struts or Corner Posts

Fabricate these members from not less than 3 X 3-inch material. These pieces must be continuous from the upper longitudinal frame member of the side to both the lower longitudinal frame member of the side and the end floorboard member. Notch the members when the top of the end floorboard does not come even with the top of the lower longitudinal member of the side. Corner posts or vertical struts are designed to receive the lag bolts from the ends of the crate.

Corner Sheathing

Locate this material on the outside at each corner of the crate. Boards used at each end of the sides must be at least 1 X 8-inch pieces, except when diagonals and are 5/8-inch-thick, the sheathing is 5/8 X 8-inch material. Nail sheathing boards to the vertical struts and corner posts with two rows (staggered pattern) of ninepenny nails. Space 8 inches apart within each row. Nail sheathing boards to 2-inch longitudinal members with clinched eightpenny nails, five at each joint. Secure to 1-inch longitudinal members with clinched nails. Use pattern shown in figure 6-50.

Ends

The ends consist of the upper, lower and intermediate longitudinal members which are the same size as the corresponding members of the sides (fig 6-41). Intermediate longitudinal members are required only when crates are 48 inches high or higher. Vertical struts of the ends are one continuous piece. All diagonal members of the ends are not less than 1 X 6-inch material. An X frame pattern is required when the width of the crate is not more than 1 1/2 times the height. When this limit is exceeded, a two-X frame pattern is required.

Partial Sheathing (Corner)

The outside vertical sheathing boards are not less than 1 X 6 inch for net loads up to 3,000 pounds, and not less than 1 X 8 inch boards for net loads over 3,000 pounds. Nail the corner board to the struts with two rows of sixpenny nails (staggered pattern). Space then 8 inches apart in each row and clinch.

Top Panels (fig 6-42)

Determine the number of panels to use by the length and width of the crate. Place the diagonal frame members as near to 450 angles as possible.

Frame Members

Use 2 X 4-inch (one edge) or 3 X 3 inch members for contents up to 4,000 pounds. Over 4,000 pounds, use 4 X 4 inch pieces. Nail 2-inch crosswise end members with twelvepenny nails, three at each joint. Nail through the side grain of the edge member into the end grain of the end member. Nail 3 X 3-inch and 4 X 4 inch crosswise end members with telvepenny nails, three at each joint, toenailed from the edge member into the crosswise end member.

Diagonal Members

All diagonal members are 1 X 6 inch boards. Nail diagonals to longitudinal members with eightpenny nails. Where diagonals cross each other, use sevenpenny nails, five at each crossing, and clinch.

End Sheathing Boards

All end sheathing boards of the top are 1 X 8 inch in size. Nail the end sheathing boards to the frame member of the top with two rows of eightpenny nails spaced 4 inches apart in a single line for 2 X 4 inch frame members. For larger members the nails are staggered. Nail sheathing boards to longitudinal members with eightpenny nails.

Table 6-14. Spacing of Diagonals for MIL-C-3774 Crates

Maximum spacing	Thickness of longitudinal members	Crate size	
		Height	Width
Inches	*Inches*	*Feet*	*Feet*
24	2	to 6	to 6
18	2	6-12	6-8
[1]18	2	12-16	to 5
24	1	to 6	to 4
18	1	6-12	4-8

[1] For crates over 32 feet in length.

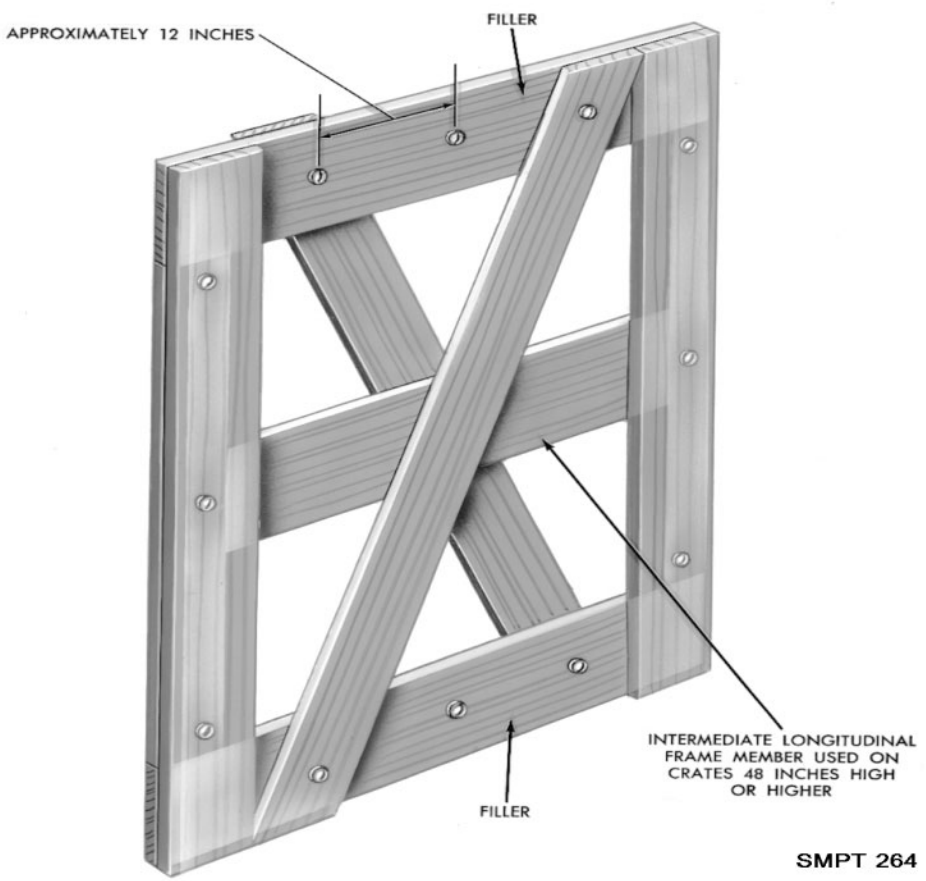


Figure 6-41. End for bolted crate (MIL-C-3774).

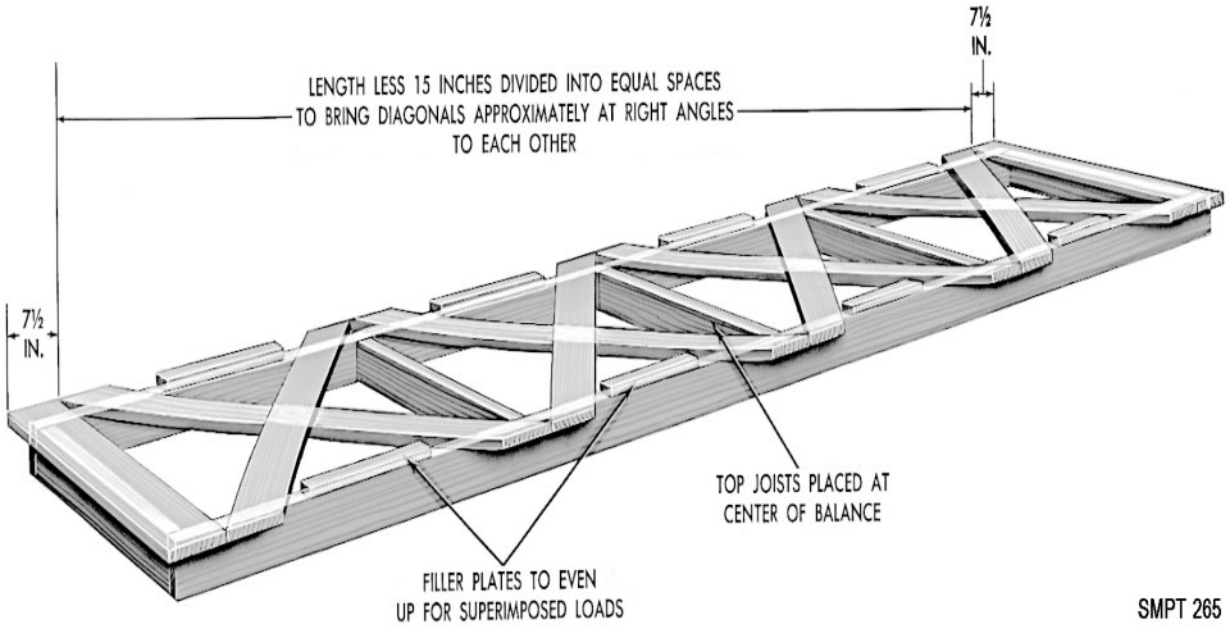


Figure 6-42. Top for bolted crate (MIL-C-3774).

Filler Strips

Fabricate filler strips from 1 X 4-inch material. Place them between the diagonals and nail. This will level the top in order to accommodate superimposed loads. Secure these strips with sixpenny nails spaced 6 inches apart.

Top Joists

Determine the size of the top joists by the width of the crate and the net weight of contents as specified in table 6-15. A single joist shall be placed between the longitudinal frame members and at the center of balance. For long crates or for crates over 10,000 pounds in weight, two sets of joists shall be used and placed not more than 43 inches on each side of the center of balance. Nail through the 2 inch longitudinal members into the end grain of the top joist with twelvepenny coated nails, three in each joist. For 4 inch joist, use five nails. Toenail joist with twelvepenny coated nails.

ASSEMBLY OF BOLTED CRATES

Requirements for Lag Bolts or Bolts

Lag bolts may be used as fasteners for assembling the various panels of a bolted crate (fig 6-5). When a single diagonal occurs on the inside of a longitudinal member, use a three-fourths inch shorter lag bolt or bolt. When the diagonal is on the outside of the frame member, use a 3/4-inch filler strip between the frame member and the member to which the part is being fastened (fig 6-41). If bolts are used, they must be machine bolts with washers placed under both the head and the nut. Use washers under the heads of all lag bolts. Space 3/8-inch lag bolts or bolts not more than 24 inches apart. Space 1/2-inch lag bolts or bolts not more than 30 inches apart. Space 5/8-inch lag bolts or bolts more than 36 inches apart.
Assembly of the panels (fig 6-43).

Fastening the Sides to the Base

The size and number of lag bolts used to fasten the side panels to the base are determined by the weight contents, the wood group used, and the width and thickness of the members as specified in table 6-13. The number of lag bolts or bolts specified in the tables are given for both side panels, one-half the number to be used on each side.

Connector plates may be used between the diagonals and skids. When used, use only half the number of lag bolts or bolts specified in tables 6-20 and 6-21. As an example, if the gross load is 8,000 pounds, use the number of bolts required in tables for 4,000 pounds. Use the correct diameter and length of fasteners specified in tables 6-16 or 6-17, through each pair of diagonals, through the lower longitudinal member of the side, and into the sides of the skids.

Fastening the Side Panels to the Top

Determine the size and number of lag bolts or bolts used to fasten the side panels to the top from the thickness of the diagonals and top frame members of the side, and the width of the longitudinal frame member of the top. Use 1/2-inch lag bolts or bolts when the combined thickness of the diagonals, the upper edge member of the side, and the longitudinal member of the top, is 4-3/4 inches or more; use 3/8-inch fasteners when the sum is less.

The length of the lag bolt should be approximately equal to the sum of the three or four thicknesses. Bolts should be long enough to accommodate the nut and washers (under head and nut).

Secure the side panel to the top by using a lag bolt or bolt through each pair of diagonals and upper longitudinal member of the side, and into the longitudinal member of the top. This is required around the perimeter of the crate (fig 6-5).

Table 6-15. Joist Sizes

Size of joist	Limits	
	Gross load	Length (crate width)
Inches	*Pounds*	*Inches*
2 x 4	1,000	72
2 x 4	2,000	60
2 x 4	3,000	48
2 x 4	5,000	36
4 x 4	10,000	[1]96
[2]4 x 4	16,000	96

[1] Use two joists for greater widths of top.
[2] Use two joists.

Table 6-16. Number of Lag Bolts for Assembling Sides to Base of Bolted Crates; Where Nominal 1-inch Longitudinal Members
Are Used in Sides and Nominal 4-inch Wide Skids Are Used

	1/2 by 6-inch lag				1/2 by 5-1/2-inch lag				3/8 by 6-inch lag				3/8 by 5-1/2-inch lag			
Net load 1/ Pounds	G1 I	G II	G III	G IV	G I	G II	G III	G IV	G I	G II	G III	G IV	G I	G II	G III	G IV
8,000	28	24	22	18	32	28	24	22	32	28	26	22	36	32	30	26
7,000	24	22	18	16	28	24	22	18	28	24	22	20	32	28	26	22
6,000	20	18	16	14	24	20	18	16	24	22	18	16	28	24	22	18
5,000	18	16	14	12	20	18	16	14	20	18	16	14	22	20	18	16
4,000	14	12	10	10	16	14	12	10	16	14	12	10	18	16	14	12
3,000	10	10	8	6	12	10	10	8	12	10	10	8	14	12	10	10
	1/2 by 5 inch lag								3/8 by 4-1/2 inch lag							
3,000	18	16	14	12					20	18	16	14				
2,500	14	12	12	10					16	14	12	10				

Note. Refers to the wood group and applies to the skids. If bolts are used, they shall be the same number and diameter as given for lag bolts.

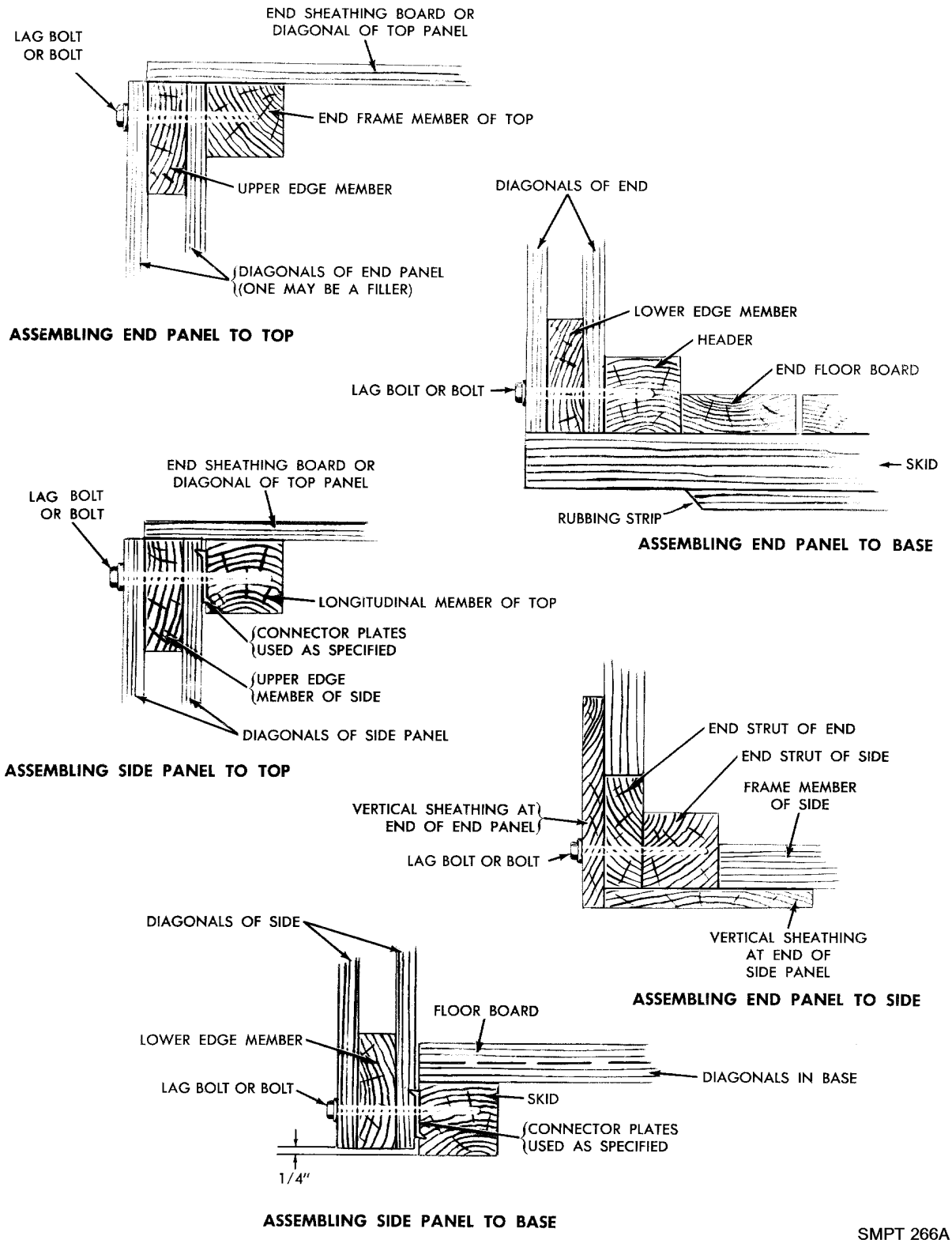


Figure 6-43. Assembly details for bolted crates (MIL-C-3774).

Table 6-17. Number of Lag Bolts for Assembling Sides to Base of Bolted Crates; Where Nominal 2-inch Longitudinal Members Are Used in Sides and Nominal 4-inch Wide Skids Are Used

Net load 1/	5/8 by 7-inch lag				1/2 by 7-inch lag				1/2 by 6-1/2-inch lag				1/2 by 6-inch lag			
	G I	G II	G III	G IV	G I	G II	G III	G IV	G I	G II	G III	G IV	G I	G II	G III	G IV
Pounds																
16,000	48	44	36	32	56	48	44	36	64	56	48	44	74	68	60	52
14,000	40	36	32	28	48	44	36	32	56	48	44	36	64	60	52	44
12,000	36	32	28	24	40	36	32	28	48	40	36	32	56	52	44	40
10,000	30	26	24	20	34	30	28	24	40	34	32	26	46	42	38	32
9,000	26	24	22	18	30	28	24	22	36	32	28	24	42	38	34	28
8,000	24	22	18	16	28	24	22	18	32	28	24	22	38	34	30	26
7,000	20	18	16	14	24	22	18	16	28	24	22	18	32	30	26	22
6,000	18	16	14	12	20	18	16	14	24	20	18	16	28	26	22	20
5,000	14	14	12	10	18	16	14	12	20	18	16	14	24	20	18	16
4,000	12	10	10	8	14	12	10	10	16	14	12	10	18	16	14	12
3,000	10	8	8	6	10	10	8	8	12	10	10	8	14	12	12	10

[1]Refers to the wood groups and applies to the skids.
Note. If bolts are used, they shall be the same number and diameter as given for lag bolts.

Table 6-18. Skid Sizes for Nailed MIL-C-3774 Crates

Maximum net load	Maximum length of crate	Size of skids
Pounds	*Feet*	*Inches*
500	12	2 X 4
2,000	12	3 X 3
10,000	16	4 X 4
12,000	16	4 X 6 (on edge)

Table 6-19. Size of Side and End Sills

Net weight of contents	Height in feet	Length of crate (feet)			
		4	8	12	16
Pounds					
2,500 to 4,000	Over 3	2 X 4	2 X 4	2 X 6	2 X 6
	3 or under	2 X 8	2 X 8	2 X 6	2 X 6
4,001 to 6,000	Over 3	2 X 4	2 X 6	2 X 6	2 X 6
	3 or under	2 X 8	2 X 6	2 X 6	2 X 6
6,001 to 8,000	Over 3	2 X 6	2 X 6	2 X 6	2 X 8
	3 or under	2 X 6	2 X 6	2 X 6	2 X 10
8,001 to 10,000	Over 3	2 X 6	2 X 8	2 X 8	2 X 8
	3 or under	2 X 6	2 X 10	2 X 10	2 X 10
10,001 to 12,000	Over 3	2 X 8	2 X 8	2 X 10	2 X 10
	3 or under	2 X 10	2 X 10	2 X 12	2 X 12

Fastening the End Panels

The diameter and length of the lag bolts or bolts for fastening the ends of the crate to the top, bottom, and sides, is determined in a manner similar to that for fastening the sides to the top.

End Panels to the Top

The size and length of fastener will depend upon the thickness of one or two diagonals or fillers, the top horizontal frame member of the end, and the width of the crosswise frame member to the top.

End Panels to the Base

The size and length of fasteners for securing the end panels to the base is the same as above.

End Panels to the Side Panels

The size and length of fasteners to secure the end panels to the side panels is as specified for fastening the sides to the top. For 5/8-inch frame in the end, for loads not exceeding 500 pounds, use 5/16-inch diameter lag screws or bolts.

Corner Strapping

Use corner strapping on all nailed and bolted crates carrying a net load of 3,000 pounds or over, to reinforce the corners and to reinforce the crate at the junction of the panel (fig 6-4). Fabricate all corner straps from 1-1/4 X .035-inch steel banding, 12 inches in length.

Apply three straps on each of the four upper corners of the crate and secure to the frame members with sixpenny nails, four in each leg of the strap. Space approximately 2 inches center to center.

Apply single straps at 36-inch intervals from the corners in all directions and nail to the frame members.

OPEN NAILED CRATES (MIL-C-3774)

DESIGN REQUIREMENTS

Nondemountable crates may be designed with either a sill or skid-type base, depending upon the requirements for the item being packed.

Skid Bases

Skid bases for open nailed crates are constructed almost identical to the bases used for bolted crates (fig 6-39).

Skid Sizes

The size of skids depends upon the net load and the length of the crate (table 6-18).

Headers

Headers are bolted to the skids with carriage bolts. The sizes of end headers and bolt sizes are as follows:

Skid size (inches)	Header size (inches)	Bolt diameter (inch)
2 X 4	2 X 4	3/8
3 X 3	3 X 3	3/8
4 X 4	4 X 4	1/2
4 X 6 (on edge)	4 X 4	1/2

Set the headers or end floorboards back from the ends of the skids the thickness of the end sheathing. When necessary, notch the headers at their ends down flush with the top of the floorboards. These notches will then accommodate and support the lower edge members of the sides. Extend the headers to the outside faces of the outer skids. The end of the base will be similar to the base of the MIL-C-104 crate (fig 6-53).

Load Bearing Floorboards

See table 6-4 for sizes.

Forklift Area

Refer to the requirements stated in bolted crate section.

Nonload Bearing Floorboards (Diagonals)

Refer to the requirements stated in bolted crate section.

Sill Bases

Sill bases are designed for loads to be transmitted to the sides by means of intermediate sills or by the end sills. The size of the side sills is based upon the weight of the contents and the length of the crate. However, sill spacing shall not exceed 48 inches center to center, whether required for transmitting loads or for bracing (fig 6-44).

Side and End Sills

The size of the side sills is obtained from table 6-19. End sills are the same size as the side sills. Overlap the side sills over the end sills and nail at the corners using twentypenny coated nails. When necessary, laminate the sills.

Intermediate Sills

Apply intermediate sills either crosswise or lengthwise of the crate. These members are always required when the width of the crate exceeds 48 inches. Determine the size by the length of the sill and the actual weight supported by the sill. Refer to table 6-31 to calculate the intermediate sill size.

Attach intermediate sills at their ends to the side or end sills by a combination of nailing and metal hangers (strap or stirrup) (fig 6-16). Metal hangers are not required for fastening nonload bearing intermediate sills.

Bridging

Use bridging to prevent the sills from buckling and to strengthen the base. Bridge intermediate sills at their ends, except when positioned on their flat faces, with 1 inch lumber of the same depth. Nail to the inner face. Reinforce spans 5 feet or over (either length or width of the crate) with 2 inch lumber the same depth as the sills. Position the reinforcing members at right angles to the sills.

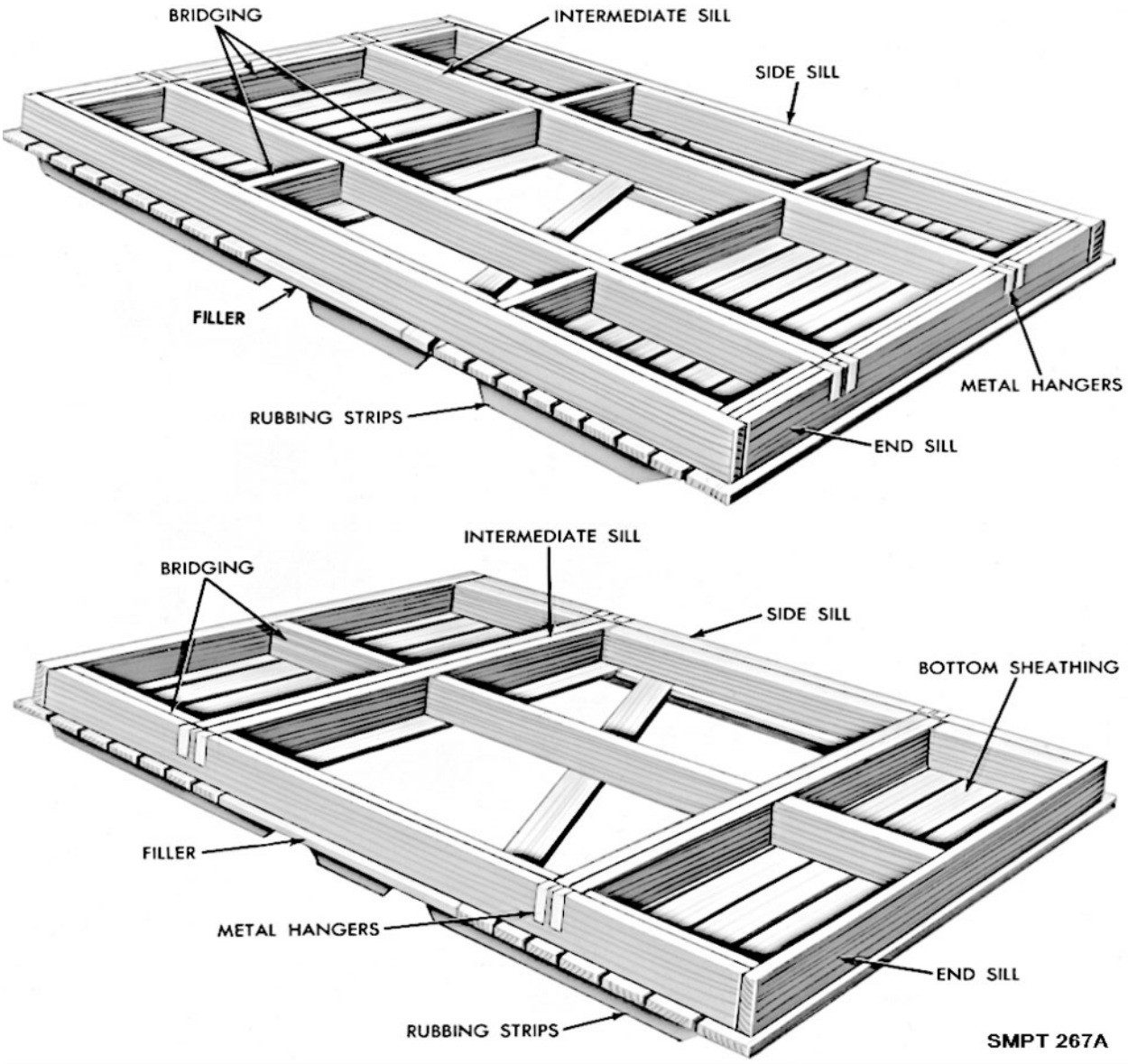


Figure 6-44. Sill base for nailed crate (MIL-C-3774).

Bottom Sheathing

Position bottom sheathing and nail crosswise to the base (at right angles to the direction of the side sills). Space the boards 1/4 to 3/8 inch apart for drainage. Use boards 4 to 10 inches wide. For the forklift area (42 in. from each end of the base) use 2 inch lumber. Use one piece sheathing boards and extend them 1/2 to 5/8 of an inch beyond the outside faces of the side and end sills. Place at least one diagonal in the unsheathed portion of the base.

Rubbing Strips

Position rubbing strips lengthwise to the crate under each longitudinal sill. Rubbing strips are always 2 inches thick and not less than 4 inches wide. The clear distance between rubbing strips should not exceed 30 inches. Cut sling notches 8 inches long in each end of the rubbing strip. Use filler strips in the unsheathed area between the sill and the rubbing strip where voids occur.

Sides

The sides consist of upper and lower frame members, vertical struts, horizontal braces, diagonals, and gusset plates (fig 6-45).

Design of the Side Panels

Determine the design of the side panel from the inside length and inside height of the crate. For crates up to 48 inches inside height use an X type frame and for crates with an inside height of over 48 inches use a HK type frame.

Member Selection

Determine the sizes of the upper and lower members, struts, and diagonals from tables 6-20 and 6-21 with the exception of the end strut or corner post. Loads referred to in the table are based on the net weight of the contents and the inside dimensions of the crate. If the exact size of the crate is not given in the table, use the member size for the crate of the next longer length, the neat greater width, and next smaller height.

Use 1 X 4 inch lumber for members and diagonals and 2 X 4 inch lumber for upper edge members when the height of the crate is 6 feet or less and the load does not exceed 4,000 pounds. Use 1 inch lumber for the lower edge members, struts and diagonals, and 2 inch lumber for the upper edge members and end struts when the height of the crate is under 6 feet and the load is over 4,000 pounds. Use 2 X 4 inch lumber for the upper and lower edge members, struts and diagonals, when the height of the crate is over 6 feet.

Upper, Lower, and Intermediate Members

The members are required to be a single continuous piece. If splicing is required, splice the members according to the details shown in figure 6-54. All splicing should be made under or over a strut whenever possible. Splicing 1 inch material is not permitted. The size of these members is based upon the gross weight and length of the crate. Intermediate members (horizontal braces) are used only for crates of the HK type.

Table 6-20. Panel Member Selection (6,000, 8,000 and, and 10,000 Pounds Net Load)[1]

Length	Members	Net load	4-foot width				6-foot width			8-foot width				
			Height (feet)				Height (feet)			Height (feet)				
			2	4	6	8	2	4	6	8	2	4	6	8
Feet		*Pounds*												
6	Upperframe members	6,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4
	Lower frame members	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Diagonals	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
8	Upper frame member	6,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4
	Lower frame member	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Diagonals	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
10	Upper frame member	6,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4
	Lower frame member	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Diagonals	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
12	Upper frame member	6,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4
	Lower frame member	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Diagonals	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 x 4	.....	.....	.....	2 X 4
16	Upper frame member	6,000	2 X 6	2 X 4	2 X 4	2 X 4	2 X 6	2 X 4	2 X 4	2 X 4	2 X 6	2 X 4	2 X 4	2 X 4
	Lower frame member	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Diagonals	6,000	.....	.....	.....	2 X 4	.....	.....	.....	2 x 4	.....	.....	.....	2 X 4
6	Upper frame member	8,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4
	Lower frame member	8,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	8,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Diagonals	8,000	.....	.....	1 X 6	2 X 4	.....	.....	1 x 6	2 x 4	.....	.....	1 X 6	2 X 4
8	Upper frame member	8,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4
	Lower frame member	8,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	8,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Diagonals	8,000	.....	.....	1 X 6	2 X 4	.....	.....	1 x 6	2 x 4	.....	.....	2 X 4	2 X 4
10	Upper frame member	8,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4
	Lower frame member	8,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	8,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Diagonals	8,000	.....	.....	1 X 6	2 X 4	.....	.....	1 x 6	2 x 4	.....	.....	1 X 6	2 X 4
12	Upper frame member	8,000	2 X 6	2 X 4	2 X 4	2 X 4	2 X 6	2 X 4	2 X 4	2 X 4	2 X 6	2 X 4	2 X 4	2 X 4
	Lower frame member	8,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	8,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Diagonals	8,000	.....	.....	1 X 6	2 X 4	.....	.....	1 x 6	2 x 4	.....	.....	1 X 6	2 X 4
16	Upper frame member	8,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4
	Lower frame member	8,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	8,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Diagonals	8,000	.....	.....	1 X 6	2 X 4	.....	.....	1 x 6	2 x 4	.....	.....	1 X 6	2 X 4

Table 6-20. Panel Member Selection (6,000, 8,000 and, and 10,000 Pounds Net Load)[1] (Continued)

Length	Members	Net load	4-foot width				6-foot width			8-foot width				
			Height (feet)				Height (feet)			Height (feet)				
			2	4	6	8	2	4	6	8	2	4	6	8
Feet		*Pounds*												
6	Upper frame members	10,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4
	Lower frame members	10,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	2 X 4	2 X 4
	Struts	10,000	.....	.....	.....	2 X 4	.....	.....	1 x 6	2 X 4	.....	1 X 6	2 X 4	2 X 4
	Diagonals	10,000	.....	.....	1 X 6	2 X 4	.....	.....	1 X 6	2 X 4	1 X 6	.....	1 X 6	2 X 4
8	Upper frame member	10,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4
	Lower frame member	10,000	.....	.....	2 X 4	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	10,000	.....	.....	2 X 4	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Diagonals	10,000	.....	1 X 6	2 X 4	2 X 4	1 X 6	1 X 6	1 X 6	2 X 4	1 X 6	1 X 6	1 X 6	2 X 4
10	Upper frame member	10,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4
	Lower frame member	10,000	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4	.....	.....	.....	2 X 4
	Struts	10,000	.....	.....	1 X 6	2 X 4	.....	.....	1 X 6	2 X 4	.....	.....	1 X 6	2 X 4
	Diagonals	10,000	.....	1 X 6	1 X 6	2 X 4	1 X 6	1 X 6	1 X 6	2 X 6	1 X 6	1 X 6	1 X 6	2 X 6
12	Upper frame member	10,000	2 X 6	2 X 4	2 X 4	2 X 4	2 X 6	2 X 4	2 X 4	2 X 4	2 X 6	2 X 4	2 X 4	2 X 4
	Lower frame member	10,000	.....	.....	.....	2 X 4	.....	.....	2 X 4	2 X 4	.....	.....	2 X 4	2 X 4
	Struts	10,000	.....	.....	1 X 6	2 X 4	.....	.....	1 X 6	2 X 4	.....	.....	1 X 6	2 X 4
	Diagonals	10,000	.....	1 X 6	1 X 6	2 X 4	1 X 6	1 X 6	2 X 4	2 X 4	1 X 6	1 X 6	2 X 4	2 X 4
16	Upper frame member	10,000	2 X 8	2 X 6	2 X 4	2 X 4	2 X 8	2 X 6	2 X 4	2 X 4	2 X 8	2 X 6	2 X 4	2 X 4
	Lower frame member	10,000	.....	.....	.....	2 X 4	.....	.....	2 X 4	2 X 4	.....	.....	2 X 4	2 X 4
	Struts	10,000	.....	.....	.....	2 X 4	.....	.....	2 X 4	2 X 4	.....	1 X 6	2 X 4	2 X 4
	Diagonals	10,000	1 X 6	1 X 6	1 X 6	2 X 4	1 X 6	1 X 6	2 X 4	2 X 4	1 X 6	1 X 6	2 X 4	2 X 6

[1]All blank spaces are 1 X 4's

Note. See text for size of end struts of sides.

Table 6-21. Panel-Member (Selection (12,000 Pound Net Load))[1]

Length	Members	Net load	4 foot width			6-foot width			8 foot width		
			Height (feet)			Height (feet)			Height (feet)		
			4	6	8	4	6	8	4	6	8
Feet		*Pounds*									
6	Upper frame members	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Lower frame members	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Struts	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Diagonals	12,000	.....	.....	(*)	.....	.....	(*)	.....	(*)	(*)
8	Upper frame member	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Lower frame member	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Struts	12,000	.....	.....	.....	.....	.....	.....	.....	.....	(*)
	Diagonals	12,000	.....	(*)	2 X 6	.....	(*)	2 X 6	.....	(*)	2 X 6
10	Upper frame member	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Lower frame member	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Struts	12,000	.....	.....	.....	.....	.....	(*)	.....	.....	2 X 6
	Diagonals	12,000	.....	2 X 6	2 X 6	.....	2 X 6	2 X 6	.....	2 X 6	2 X 6
12	Upper frame member	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Lower frame member	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Struts	12,000	.....	.....	.....	.....	.....	2 X 6	.....	2 X 6	2 X 6
	Diagonals	12,000	.....	.....	2 X 6	.....	2 X 6	2 X 6	.....	2 X 6	2 X 6
16	Upper frame member	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Lower frame member	12,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Struts	12,000	.....	.....	.....	.....	.....	2 X 6	.....	.....	2 X 6
	Diagonals	12,000	.....	.....	2 X 6	.....	.....	2 X 6	2 X 6	2 X 6	2 X 6

NOTES:
1. All blank spaces are 2/4's.
* The above sizes are for uniform loads but apply also to concentrated loads where an asterisk is shown. When asterisk is shown, increase the member size to 2x6 for concentrated load.

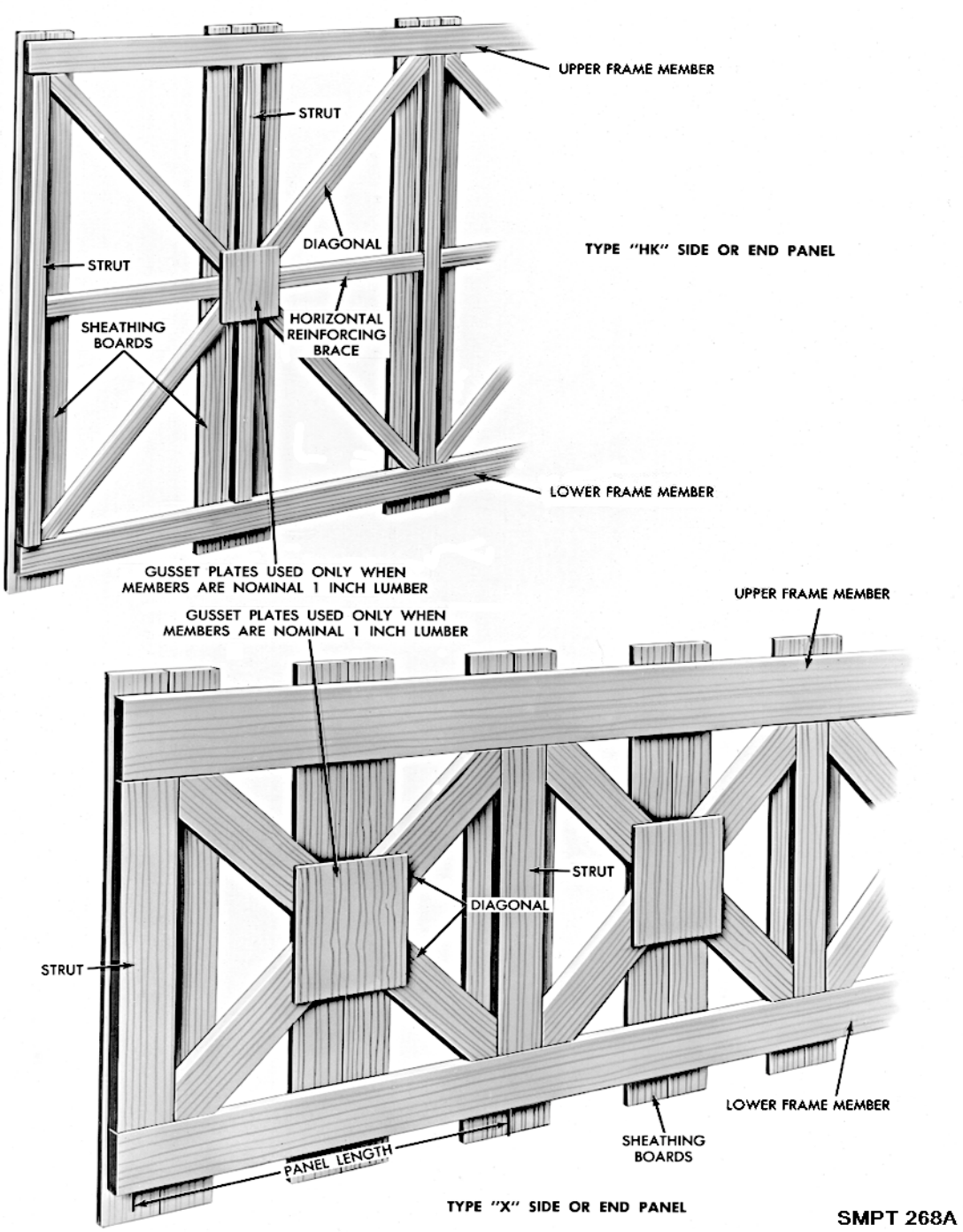


Figure 6-45. Side or end panel for nailed crate (MIL-C-3774).

Vertical Struts and Diagonals

All vertical struts and diagonals are continuous from the lower frame member to the upper frame member. Cut the diagonal and horizontal braces to fit between the vertical struts.

End Struts or Corner Posts

The end vertical strut or corner post of the side is not less than 2 inches in thickness in order to provide sufficient nailing space when fastening the ends.

Partial Sheathing Boards

Always apply the sheathing boards vertically. These boards are located at the corners and at various intervals based upon the design of the crate.

Lumber Sheathing

The sheathing boards are of one piece material, 1 inch thick, and from 4 to 10 inches wide. All end boards ar at least 6 inches wide, preferably wider. Ten percent of the boards may be 4 inches wide, but no narrow boards may be adjacent to each other.

Plywood Sheathing

Plywood strips, three or five ply material, may be substituted for lumber sheathing in the sides, ends, or tops. This material must be the same width as the lumber sheathing. For loads up to 5,000 pounds, use 7/16 inch plywood of group I woods; 3/8 inch of group II woods; 5/16 inch of group III and IV woods. For loads over 5,000 pounds, use 1/2 inch plywood of group I woods; 7/16 inch of group II woods; 3/8 inch of group III and IV woods.

Gusset Plates

Gusset plates are required for crates using 1 inch frame members. Place the gusset plates where the diagonals, struts, or horizontal braces intersect. Plywood gusset plates are not required when plywood sheathing is used. Use 12 X 12 X 1/4 inch gusset plate for 1 X 4 inch frame members. Use 18 X 18 X 1/4 inch gusset plate for 1 X 6 inch frame members. Secure the gusset plates to frame members using sevenpenny nails and clinch (fig 6-45).

Nailing Lumber Sheathing

Nail 4 to 6 inches wide sheathing boards of horizontal and diagonal members with three rows of ninepenny clinched nails. Use three nails in sheathing boards 4 to 6 inches wide and four nails in wider boards. Nail sheathing boards over 6 inches wide to horizontal and diagonal members with four rows of ninepenny clinched nails. Nail sheathing boards 4 to 6 inches wide to vertical struts with two rows of ninepenny nails, spaced 6 inches apart in each row and clinch.

Nailing Plywood Sheathing

Nail plywood sheathing to 4 inch wide frame members with two rows of nails, spaced 6 inches apart in each row, and clinch. Use three rows in frame members over 4 inches wide. The nailing requirements are identical to those illustrated in figure 6-5 except for the spacing.

Ends

The end frame members are identical to those of the sides. The design of the end panels is also based upon the inside length and inside height of the crate. The panel design will be either X or HK framing (fig 6-45).

Member Selection

The frame members of the ends are the same size as the corresponding members of the sides.

Top Panels

The top panels consist of framing members, partial sheathing boards, gusset plates and joists. Tops are classified according to types (table 6-22 and fig 6-46).

Number of Panels

To determine the number of panels for N, X or HK type of top, divide the crate length by the crate width and use the nearest whole number.

Frame Members

All top frame members are 1 X 6 inch material. When the width of the top is 24 inches or less use 1 X 4 inch material.

Gusset Plates

Use gusset plates at the intersection of the frame members of the top. They are the same size and nailed in the same manner as those for the side and end panels.

Top Joists

Determine the size of the joists by the weight of the contents and the length of the joists (table 6-15). Space the joists not more than 48 inches center to center. Extend all joists from the upper longitudinal member of one side to the upper longitudinal member of the other side. Fasten each joist with three twelvepenny coated sinkers through the upper edge members of the side into the end of the joist when the framing is one inch thick. Use three twentypenny nails per joint for 2-inch upper frame members. This nailing is accomplished as the crate is being assembled.

FABRICATION OF OPEN NAILED CRATES

Sheathing to the Horizontal and Diagonal Frame Members

Use nails for securing the sheathing to the frame members (up to and including 2-inch thickness) long enough to permit clinching at least one-fourth of an inch. Use three rows of nails to secure the sheathing. Use a minimum of three nails in each sheathing board up to 6 inches wide. Use not less than four nails in wider boards.

Sheathing to the Vertical Frame Members

Use two rows of nails, placed on 6-inch centers, in each row and stagger (table 6-24 and figure 6-46).

Plywood Sheathing to the Frame Members

The nails for fastening plywood to framing members shall be long enough to pass through the plywood and the frame member and be clinched not less than one-fourth of an inch. Stagger all nails in two parallel rows in each frame member up to 3-5/8 inches wide, and in three rows in wider frame members. Place the nails not less than one-half of an inch from the edge of the frame members. The distance between rows of nails is not less than 1 inch, and the distance between adjacent nails in any row is not to exceed 6 inches.

Sheathing to the Side Frame Members of the Top

Use two rows of nails. One row three-fourths of an inch from the inside edge of the frame member, and one row three-fourths of an inch from the outside edge. Stagger the nails between rows with a minimum of two clinched nails in each sheathing board at each longitudinal member.

Sheathing to the End Frame Members of the Top

Place one row of nails in three-fourths of an inch from the inside edge of the frame member. Place the other row in the center of the frame members. Space the nails 9 inches apart in each row and clinch.

Sheathing to the Longitudinal and Diagonal Members of the Top

Use three rows of nails, with not less than three nails in sheathing boards 6 inches wide. Use not less than four nails in wider boards.

Sheathing to the Struts of the Top

Two rows of nails are required not less than three-fourths inch from the edges of both the frame members and the sheathing. Space the nails on 9-inch centers in each row and clinch.

Plywood Sheathing to the Frame Members of the Top

If plywood is substituted for lumber, stagger the nails in two parallel rows and space them 6 inches apart in each row. Position the nails three-fourths inch from the edge of the frame members. The nails must be long enough to penetrate both the members and be clinched at least three-fourths of an inch.

Table 6-22. Type of Tops (MIL-C-3774)

Type framing pattern	Width of top (in.)
N.....	Up to 40
X.....	Over 40 through 60
HK.....	Over 60 through 96

Table 6-23. Nailed Crate Assembly (MIL-C-3774)

Fasten		Size type of nail	Maximum spacing	Notes
Part	To part			
			Inches	
Corner strut of end - (1-inch member)	Corner of strut of the side	12d	12	
Corner strut of end - (2-in. member)	Corner strut of the side	20d	12	
Sheathing of side	Corner strut of the end	8d	6 to 8	Predrill through sheathing of end and corner strut of end.
Edge frame member of top - (through sheathing)	Upper frame member of sides	12d	6 center to center	Stagger
Edge frame member of top	Upper frame member of sides	8d	6 to 8	Space nails between top sheathing
End strut of top	Upper frame member of end	12d	6	Stagger

Table 6-24. Nailed Per Each 1,000-Pound Gross Load; Nailing Side Sheathing to Skids or Sills and End Sheathing to Headers and Sills

Nail	Wood groups of skids			
Type	Penny size	II	III	IV
Common	7	20	21	16
Sinker or cooler	7	23	26	19
Sinker or cooler	8 or 9	19	21	16
Sinker or cooler	10	18	19	14
Corker	8 or 9	17	19	14

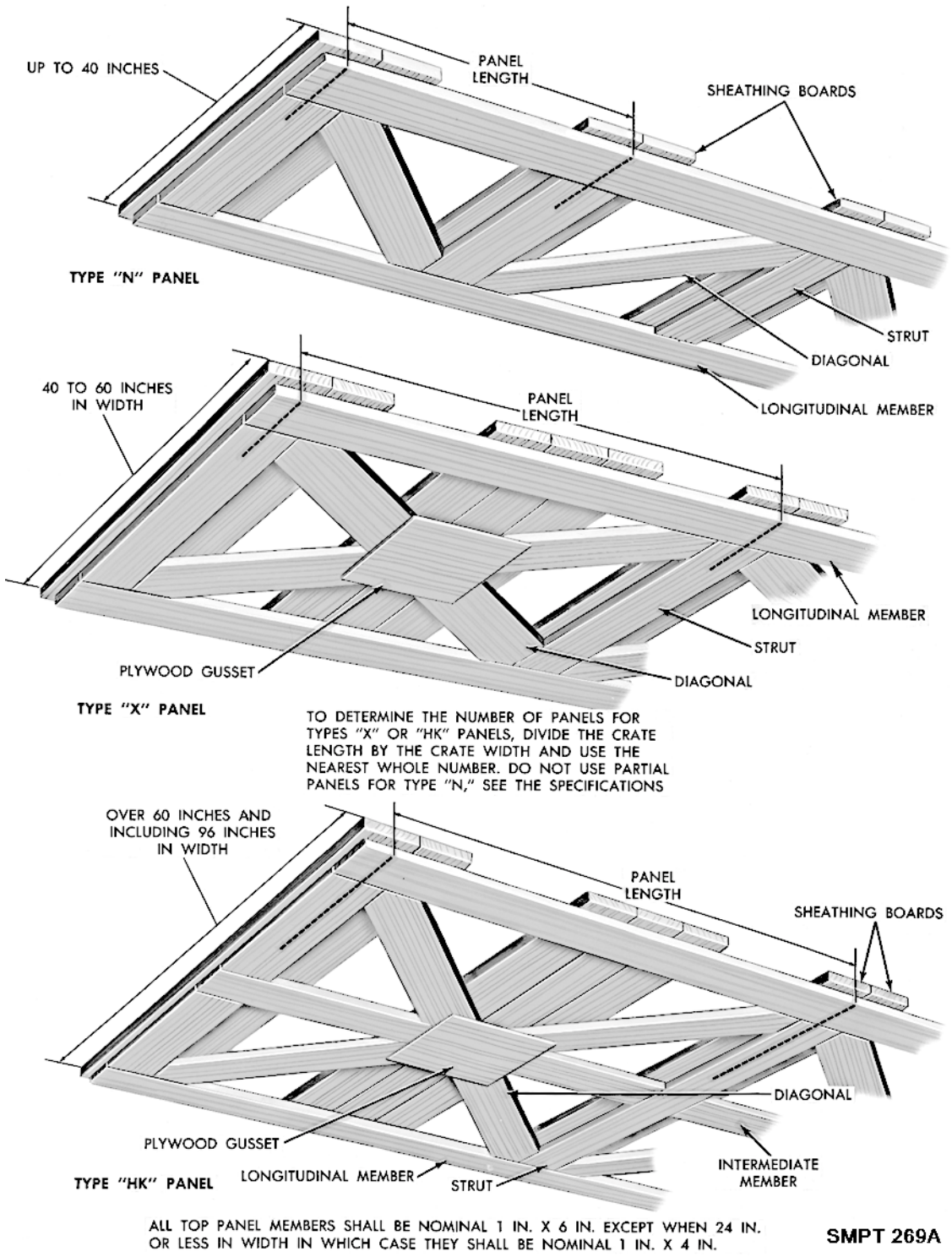


Figure 6-46. Types of top panels (MIL-C-3774).

ASSEMBLY OF OPEN NAILED CRATES (FIGS 6-4, 6-47 AND 6-48)

Nailing Requirements

The nailing requirements for fastening the base, sides, ends, and top together are found in tables 6-23 and 6-24.

Nailing Procedures

When attaching the sides and ends to the skids, use one row of nails (staggered) for 2 inch-deep skids, two rows for 3 and 4 inch-deep sills and three rows for deeper members. Secure the corner struts of the end to the corner struts of the side with twentypenny nails spaced 12 inches apart. Nail the partial sheathing of the side to the corner strut of the end using eightpenny nails, spaced 6 to 8 inches apart, and staggered. Nail through the top sheathing into the upper edge members using twelvepenny nails spaced 6 inches apart, center to center. Nail the top sheathing to the top joists using twelvepenny nails, spaced 8 inches apart.

Corner strappings (figs 6-4 and 6-18)

SHEATHED WOOD CRATES, MIL-C-104 (GENERAL)

MIL-C-104 covers requirements for two types and two classes of sheathed crates each of which may have two styles of bases. The crates are designed for net loads not exceeding 30,000 pounds and to withstand the most severe overseas shipping and storage conditions.

CLASSIFICATION

Eight crate designs are possible through the combination of the following types, classes and styles. These crates are available in different type, classes, and styles. For example a type I (nailed), class 2 (plywood sheathed), Style A (skid base) crate may be used.

Type I - Nailed
Type II - Bolted
Class 1 - Lumber sheathed
Class 2 - Plywood sheathed
Style a - Skid base
Style b - Sill base

Weight Limitations

The gross weight of these crates should not be more than 11,200 pounds whenever practical. This weight is recommended in order to permit handling with ship's gear. However, when this limitation is not possible, the gross weight may be greater than 11,200 pounds but less than 20,000 pounds for crates with Style B (sill) bases, or 30,000 pounds for crates with Style A (skid) bases.

Dimension Limitations

The exterior dimensions of the crate shall not exceed the following limitations, unless specified, for overseas shipment for which dimensions of the International Loading Gauge shall apply.

Length - 30 feet Width - 9 feet Height - 10 feet

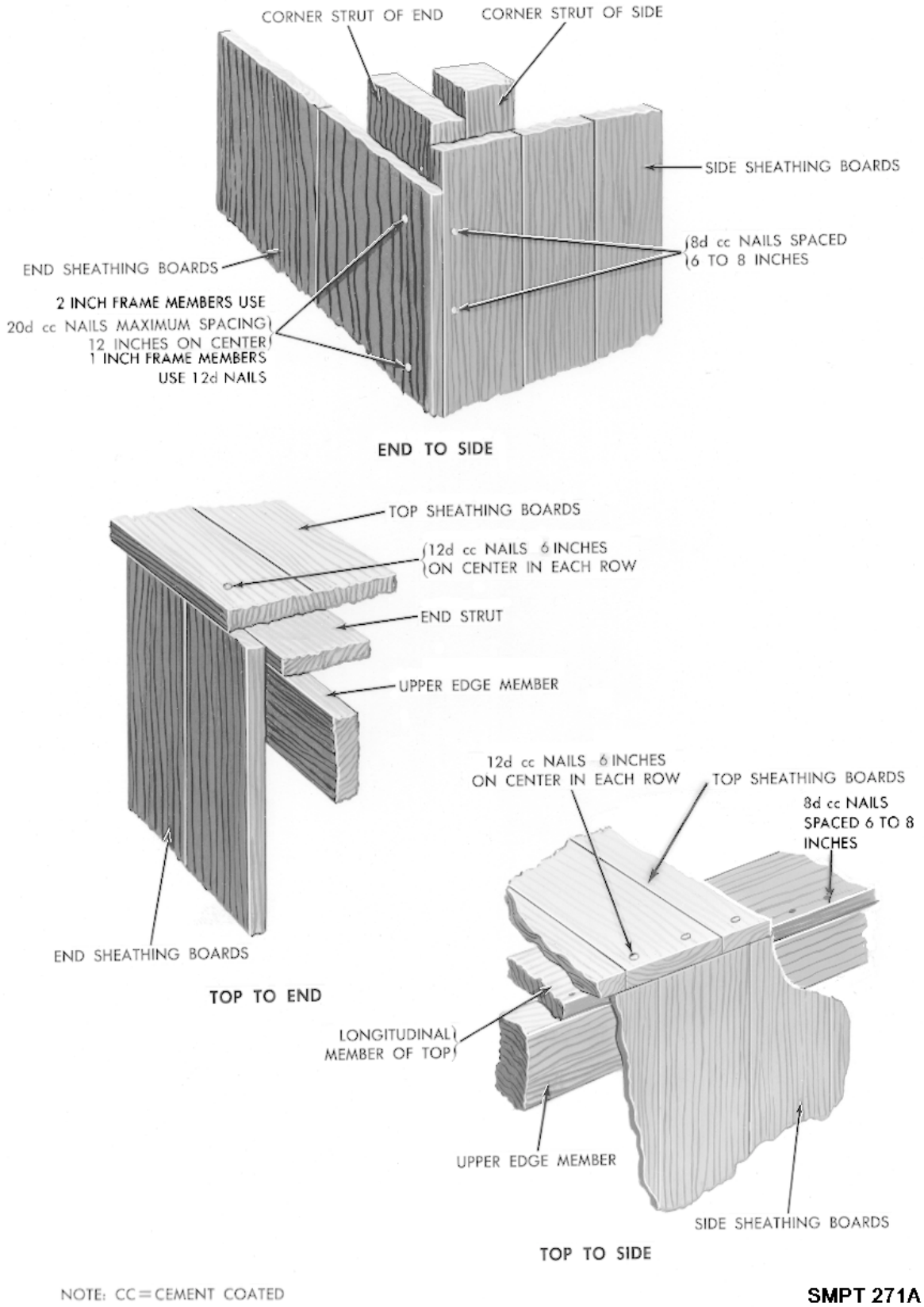


Figure 6-47. Assembly of open nailed crates (MIL-C-3774).

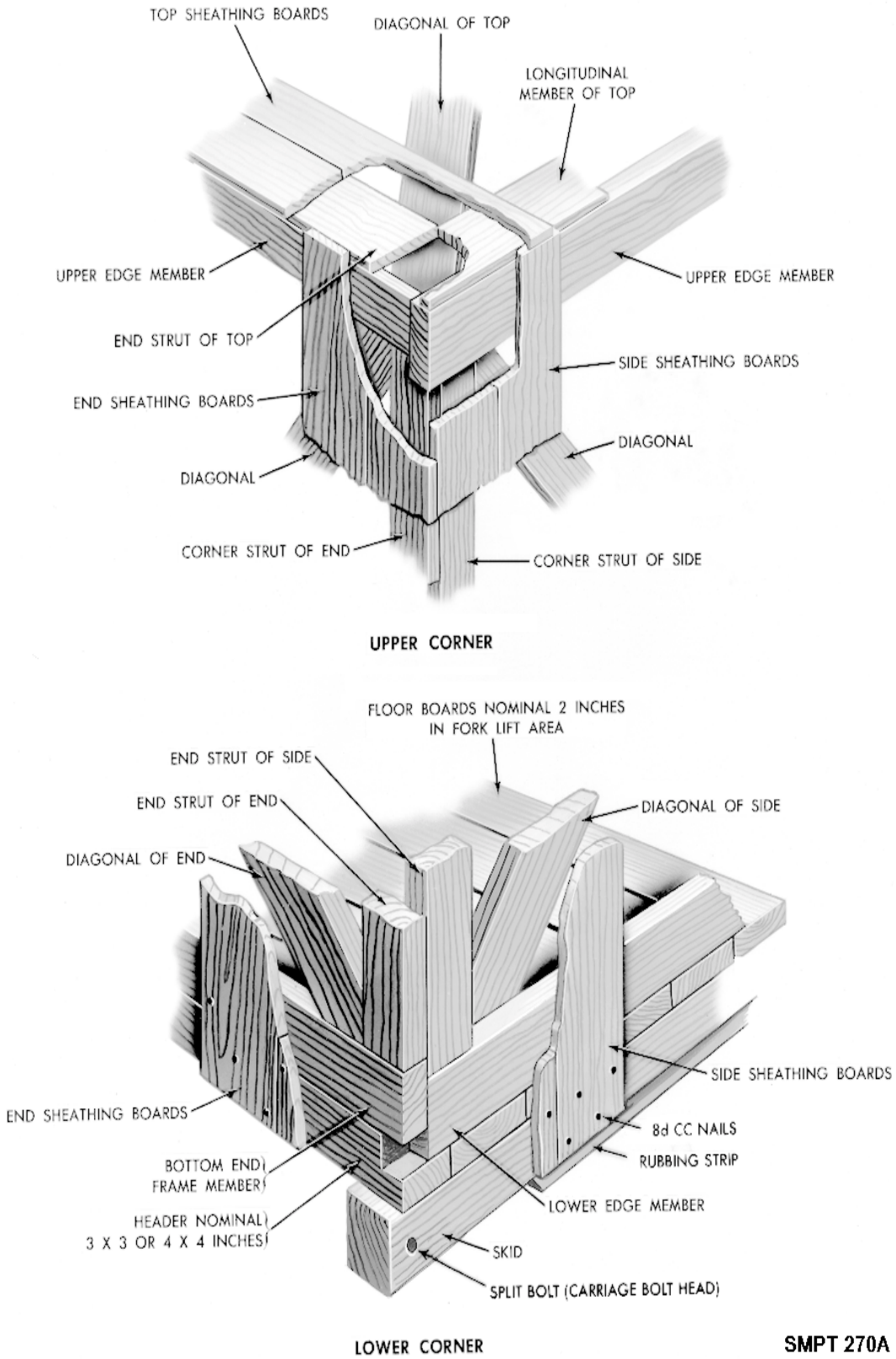


Figure 6-48. Assembly details for nailed crates (MIL-C-3774).

Interior Clearance

A clearance of not less than 1 inch shall be allowed between the item and the closest member of the sides, ends, and top of the crate. Fragile items or items within floating bag barriers shall be protected with clearances of not less than 2 inches. Additional clearances may be provided for shock mounted items. Protruding parts at the top may be allowed to extend between joists; spacing of joists may be adjusted slightly to accommodate projections.

MATERIAL REQUIREMENTS

Material

Material shall be as specified herein. Materials not specified shall be selected by the contractor and shall be subject to all provisions of MIL-C-104 specification.

Lumber

Lumber components shall conform to woods commonly used.

Plywood

Plywood shall conform to A-A-55057 Type A or B. Plywood (type A or B) shall comply with PS1 and PS2.

Nails and Staples

Nails and staples shall be steel and shall conform to ASTM F 1667-95.

Nuts, and Washers

Nuts shall conform to FF-N-836, Type I or II, style 1 or 4. Washers shall conform to FF-W-92, Type A, Grade I, Class A.

Strapping

Strapping shall conform to ASTM D 3953, Type 1 or 2 as applicable. Finish shall be A, B, or C.

Barrier Material

Barrier material, for crate liners, shall conforms to PPP-B-1055, class as appropriate for crate liners.

CONSTRUCTION

Nailing Procedure

Nails used shall be sinkers, coolers,, corkers, or common. Nails sizes specified for the fabrication of the various crates are based on Groups I and II woods. When Groups III or IV woods are used, nails sizes may be onepenny size smaller than those specified. The patterns to be used for the nailing of two flat pieces of lumber shall conform to the details shown in figure 6-50). Unless otherwise specified herein, the following requirements shall determine size, placement, and quantity of nails:

- All adjacent crate members shall be securely fastened to each other, either directly or by means of the covering.
- All nails that are not to be clinched shall be cement-coated.
- Nails shall be driven through the thinner member into the thicker member wherever possible.

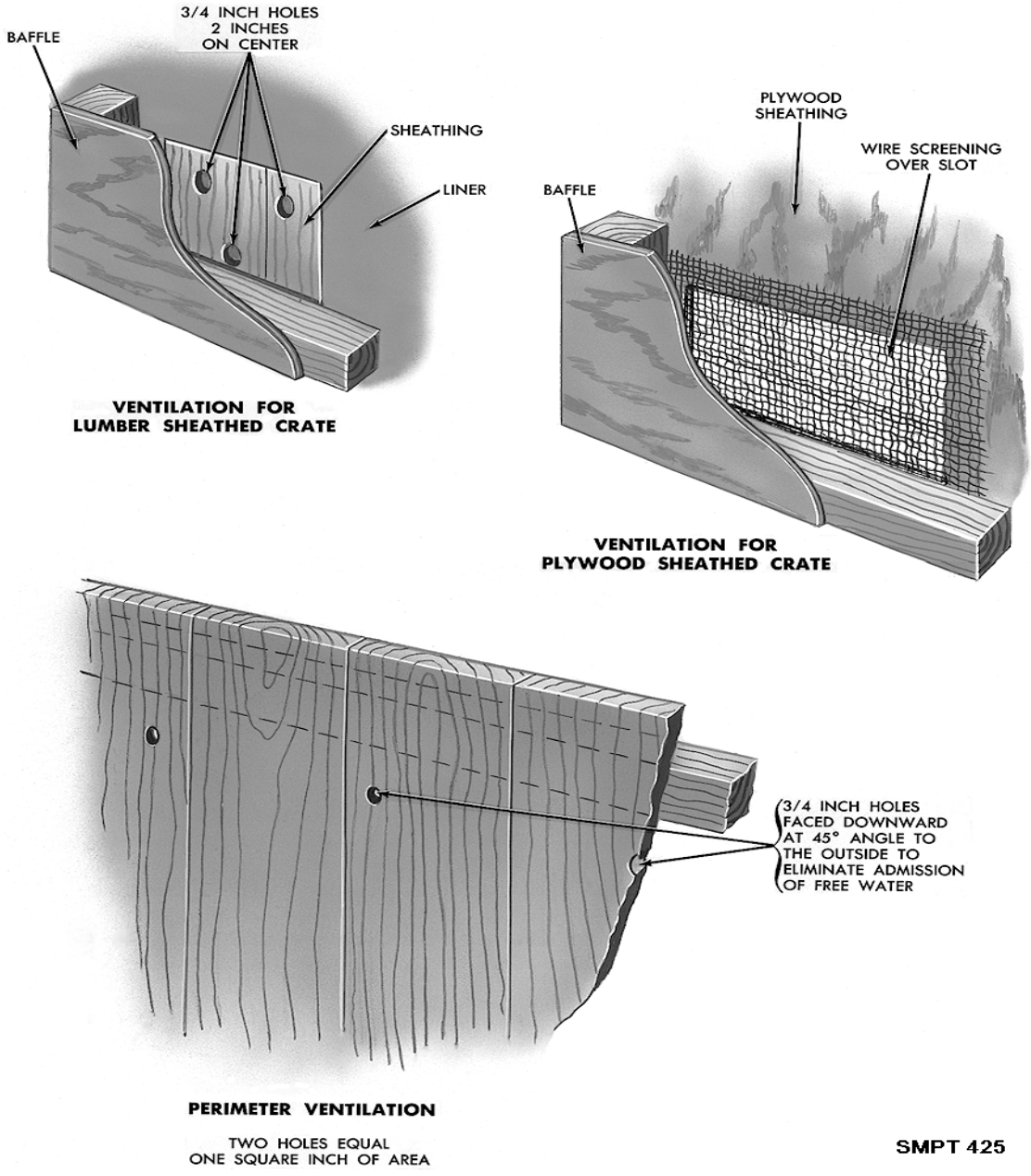


Figure 6-49. Ventilation end screening of sheathed crates.

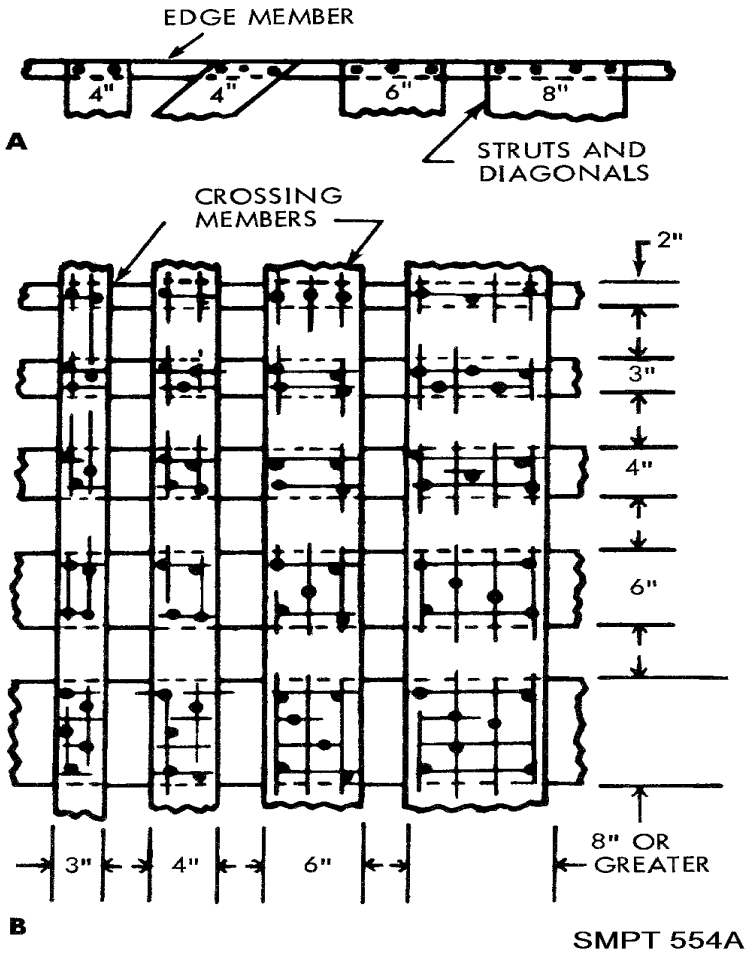


Figure 6-50. Nailing patterns.

- Nails for fastening plywood to framing shall be clinched at least 1/4 inch. Heads of nails shall always be on the plywood side.
- When the flat faces of pieces of lumber are nailed together and the combined thickness is 3 inches or less (except for top joists and covering material), nails shall be long enough to pass through both thicknesses and shall be clinched not less than 1/4 inch or more than 3/8 inch.
- When the flat faces of pieces of lumber are nailed together and the combined thickness is more than 3 inches or when the flat face of one or more pieces is nailed to the edge or end face of another, nails shall not be clinched. The portion of the nail in the thicker piece shall not be less than 2 times the length of the nail in the thinner piece for tenpenny nails and smaller, and not less than 1-1/2 inches for twelvepenny nails and larger.
- When splitting occurs with the use of diamond-point nails, the nails shall be slightly blunted. When blunting does not prevent the splitting, holes slightly smaller than the diameter of the nail shall be drilled for each nail.
- Nails shall be driven so that neither the head nor the point projects above the surface of the wood. Occasional over-driving will be permitted, but nails shall not be over-driven more than one-eighth the thickness of the piece holding the head.

- Nails shall be positioned not less than the thickness of the piece from the end and not less than one-half the thickness of the piece from the side edge of the lumber whenever possible. Nails driven into the side edge of lumber shall be centered on the side edge.
- Nails securing plywood sheathing to frame members shall be spaced as shown in figure 6-51. Machine driven nails having a definite head may be used for securing plywood sheathing providing they meet size requirements specified herein.

Stapling

Staples may be used to fasten sheathing to frame members. They shall not be used for fabrication of bases, fastening of framing members to each other, or for assembly of crates. Staples shall have crowns of not less than 3/8 inch wide and shall have a wire diameter of not less than 0.062 inch (16 gage). Straight leg staples shall be long enough to provide a minimum 1/4-inch clinch. Divergent point staples shall not be less than 1 inch long. Spacing of staples shall be the same as for nails. Staples shall always be driven from the plywood side.

Bolt Application

Holes shall be prebored to receive carriage bolts and shall be the exact diameter of the bolt. The lead holes for lag bolts shall be the same diameter as the shank, even though the threaded portion may have a greater diameter than the shank, and shall be as shown in table 6-25.

Lag bolts shall be placed by being turned in their holes the full length of the bolt and shall not be driven in with a hammer or by any similar means. If, for any reason, the thread in the wood is stripped when the lag bolts are placed, the lag bolt shall be removed and placed in a new hole near the old position. A flat washer shall be used under the head of each lag bolt and under the nut of each carriage bolt. After the nut is placed, the thread of the carriage bolt projecting beyond the nut shall be painted with a suitable metal primer or similar material.

Ventilation (figs 6-49 and 6-51)

All crates shall be provided with ventilating holes or slots which shall be located at each end or at ends and sides of lumber and plywood sheathed crates, or around the perimeter of plywood and lumber sheathed crates. These ventilating holes or slots shall be located immediately below the top frame member and be provided with a baffle as shown in figure 6-51 when slots are used in plywood sheathed crates or when holes are in clusters in lumber sheathed crates. Single holes drilled without baffles shall be sloped at 45 degrees to drain outward. No holes or slots shall be cut in any frame member.

Class 1 Crates

Class 1 crates shall be provided with ventilation holes, 3/4 inch in diameter. The crate liner shall be removed from the ventilating area and all splinters and chips shall be removed from the holes.

End Ventilation

Ventilating holes shall be provided in each end in one or more clusters, placed near the upper frame members, provided with a baffle, and spaced 2 inches on center as shown in figure 6-51. In small crates, holes may be located so that diagonals or struts can be utilized in part for cleats. In crates over 10 feet in length, the ventilating holes shall be divided equally between

the sides and ends with a baffle provided for each group of holes. The clusters of holes shall be located as near the midpoint of the side and end as practical. The number of holes shall comply with table 6-26.

Perimeter Ventilation

As an alternate to end ventilation, the 3/4 inch ventilating holes may be spaced evenly around the perimeter of the crate just under the top frame member and drilled at a 45 degree angle to drain outward (fig 6-49). The total number of holes shall comply with table 6-26.

Table 6-25. Lag bolt lead hole sizes.

Diameter of Threaded Portion of Lag Bolt (inch)	Diameter of Lead Hole (inch)	
	Groups I, II, and III Woods	Group IV Woods
1/4	3/16	3/16
5/16	1/4	1/4
3/8	1/4	5/16
1/2	3/8	7/16
5/8	3/8	1/2
3/4	1/2	5/8

Table 6-26. Ventilation holes and area required.

Lumber-sheathed crates			Plywood-sheathed crates
Volume of crate (cu. ft.)	End ventilation minimum number of 3/4 inch diameter holes required in each end (place in cluster and use baffle)	Perimeter ventilation (alternate) Total minimum number of 3/4 inch diameter holes required around perimeter (space evenly and slope to drain out)	Area required in each end (Use baffle and screen) (sq. in.)
0-100	3	6	7
100-150	4	8	10
150-200	5	10	14
200-400	9	18	27
400-600	14	27	40
600-800	18	36	52
800-1,000	22	44	66
1,000-1,200	27	54	80
1,200 and over	33	66	100

Note. In large crates, where a large ventilating area is required, two or more slots or clusters of holes may be used in each panel.

Class 2 Crates

Class 2 crates shall be provided with a horizontal slot in each end. The ventilation slots shall be provided with baffles and screens as shown in figure 6-51. The required ventilating area shall comply with table 6-26. In crates over 10 feet in length, the ventilation area shall be divided equally between the sides and ends of the crate with baffle and screen provided for each ventilating area. The ventilating area shall be placed as near the midpoints of the sides and ends as practical. In small crates, 3/4 inch diameter holes may be substituted for the slots in the proportion of two holes for each square inch of required area.

Class 1 Crates

Class 1 crates may be either bolted or nailed. Bolted crates shall be so designed that the major components of base, sides, ends, and top may be assembled to each other with lag bolts in order that the crate can be readily disassembled and, if desired, reassembled without major damage to the parts. Nailed crates are assembled with nails and straps, are not easily demountable, and because of probable damage during disassembly, are not generally reused. A combination of top, side, and end panels may be fabricated and assembled to each other as specified for nailed crates, and the unit fastened to the base as specified for bolted crates.

Bases

Bases shall be designed to support the weight of the crated article only when the sides and ends are fastened in place.

Skid Type (Style a)

Style a bases shall consist of longitudinal skids and rubbing strips, headers, load-bearing floorboards, and flooring as shown on figures 6-52 and 6-53. Details of construction shall be the same for bolted and nailed crates.

Table 6-27. Allowable minimum skid sizes

Maximum netload (lb.)	Maximum length of crate (ft.)	Nominal size of skids (in.)
300	16	2 X 4 (flat) 1/
1,000	12	2 X 4 (flat) 1/
2,000	20	3 X 3 or 3 X 4 (flat) 2/
10,000	32	4 X 4
30,000	20	4 X 6 (on edge)

1/ For nailed crates only.
2/ For crates with 2-inch-thick lower frame member or 2-inch end struts.

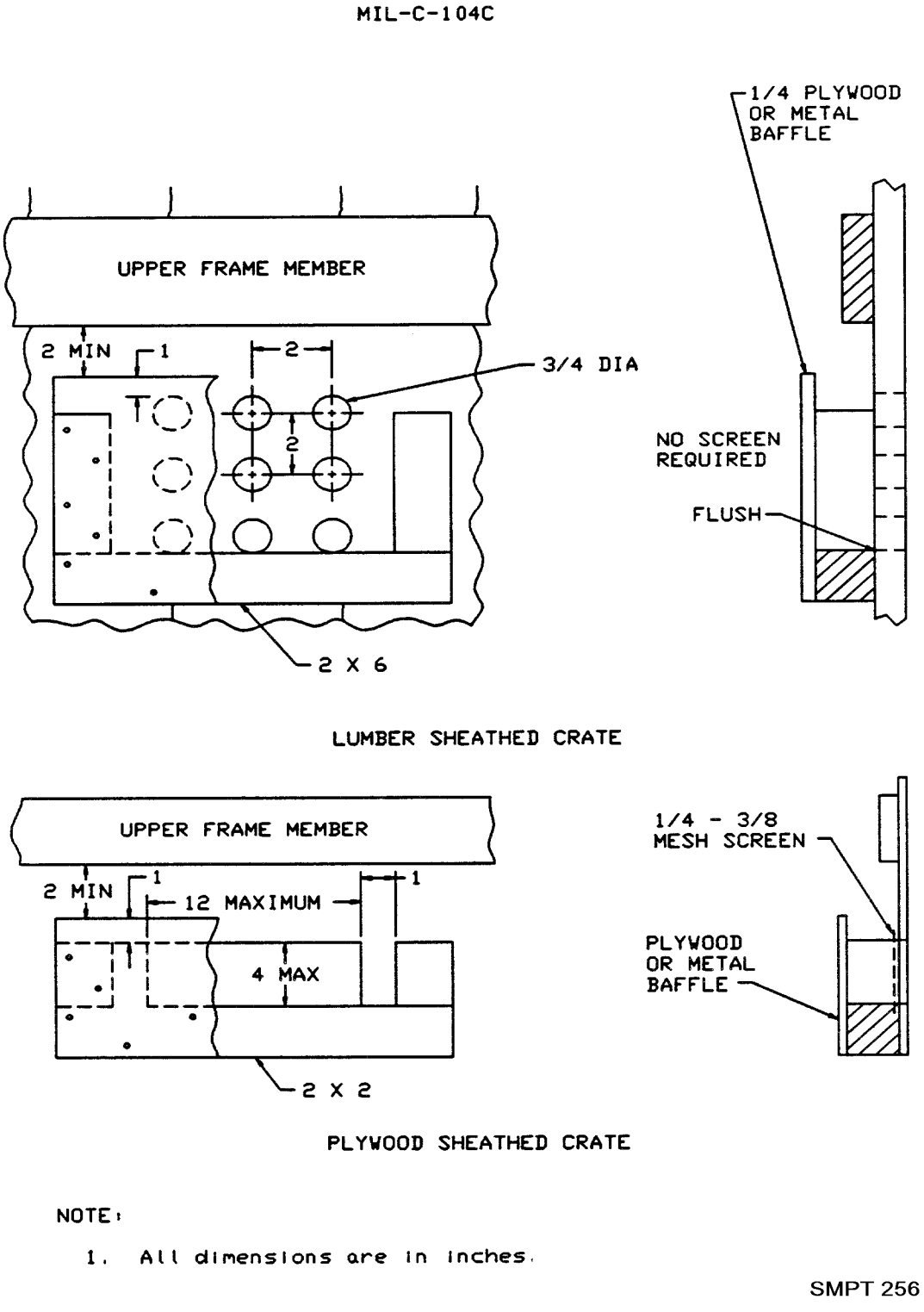
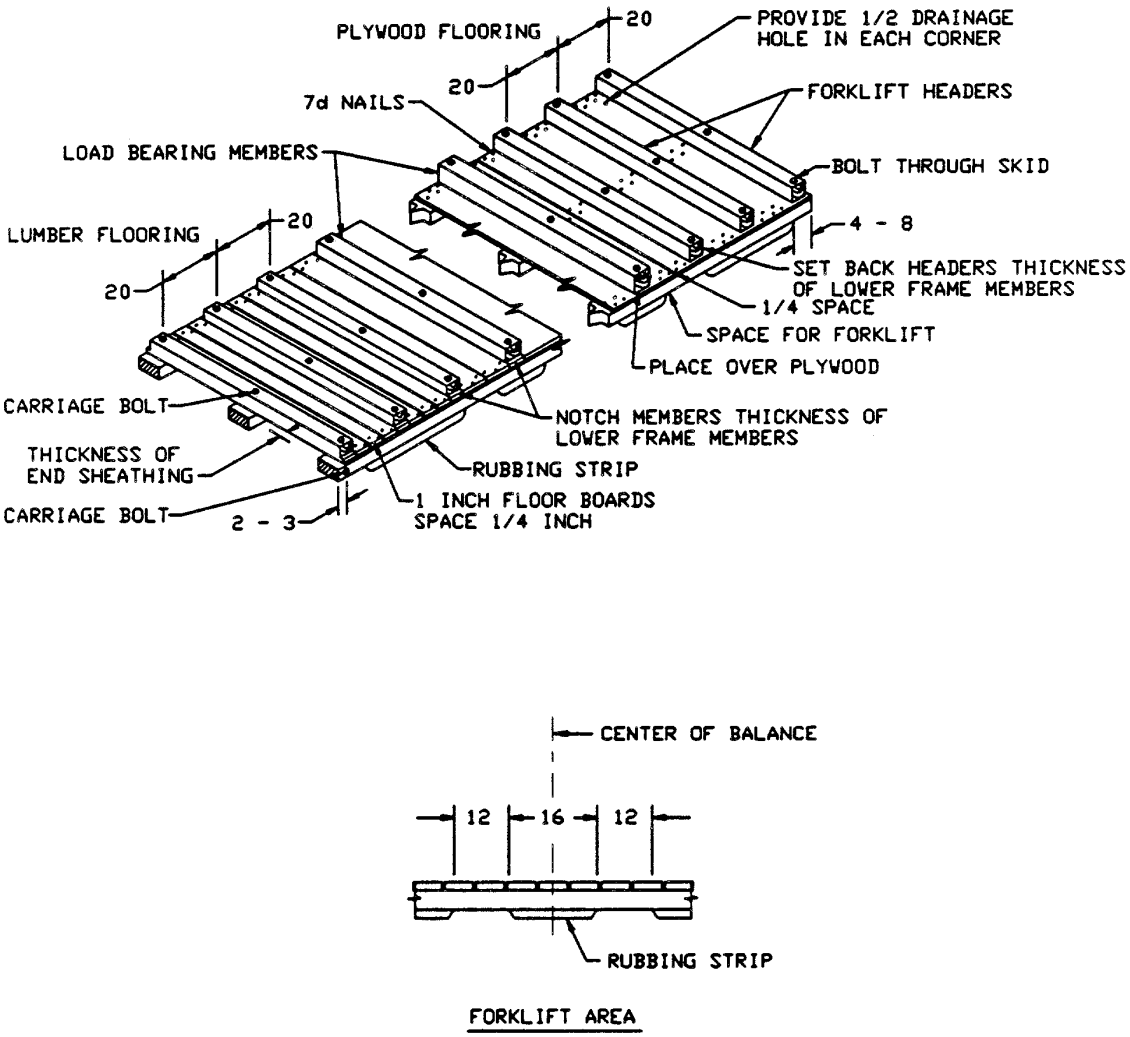


Figure 6-51. Ventilation of lumber and plywood sheathed crates (MIL-C-104).

MIL-C-104C



Note:

1. All dimensions are in inches.

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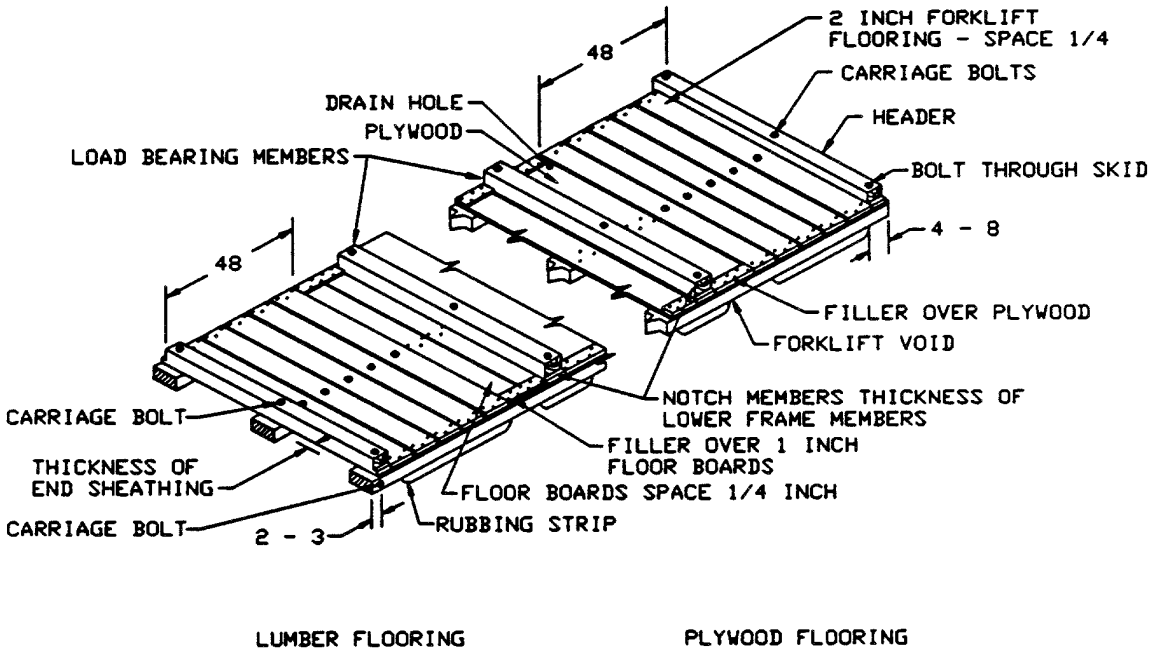
Figure 6-52. Skid base plywood flooring (MIL-C-104).

MIL-C-104C



Note:

1. All dimensions are in inches.

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Figure 6-53. Skid base lumber flooring (MIL-C-104).

Skids

Any species of wood except Groups I shall be used for skids. Skids shall be spaced no farther apart than 48 inches, center to center, across the width of the base. Minimum size shall be as shown in table 6-27. When either the length or net load exceed the maximum shown, the next larger skid shall be used.

When necessary, skids may be spliced or laminated according to the details shown in figures 6-54 and 6-55, but the use of 2 x 4 inch skids shall be limited to such lengths that no splicing would be required. Whenever possible splices shall be made not more than one-third of the length of the base from the ends of the skid and the splice locations alternated in adjacent skids. To prevent splitting, all skids shall have a carriage bolt placed crosswise and 2 to 3 inches back from each end of the skid as shown in figure 6-55. Bolt sizes shall comply with table 6-28.

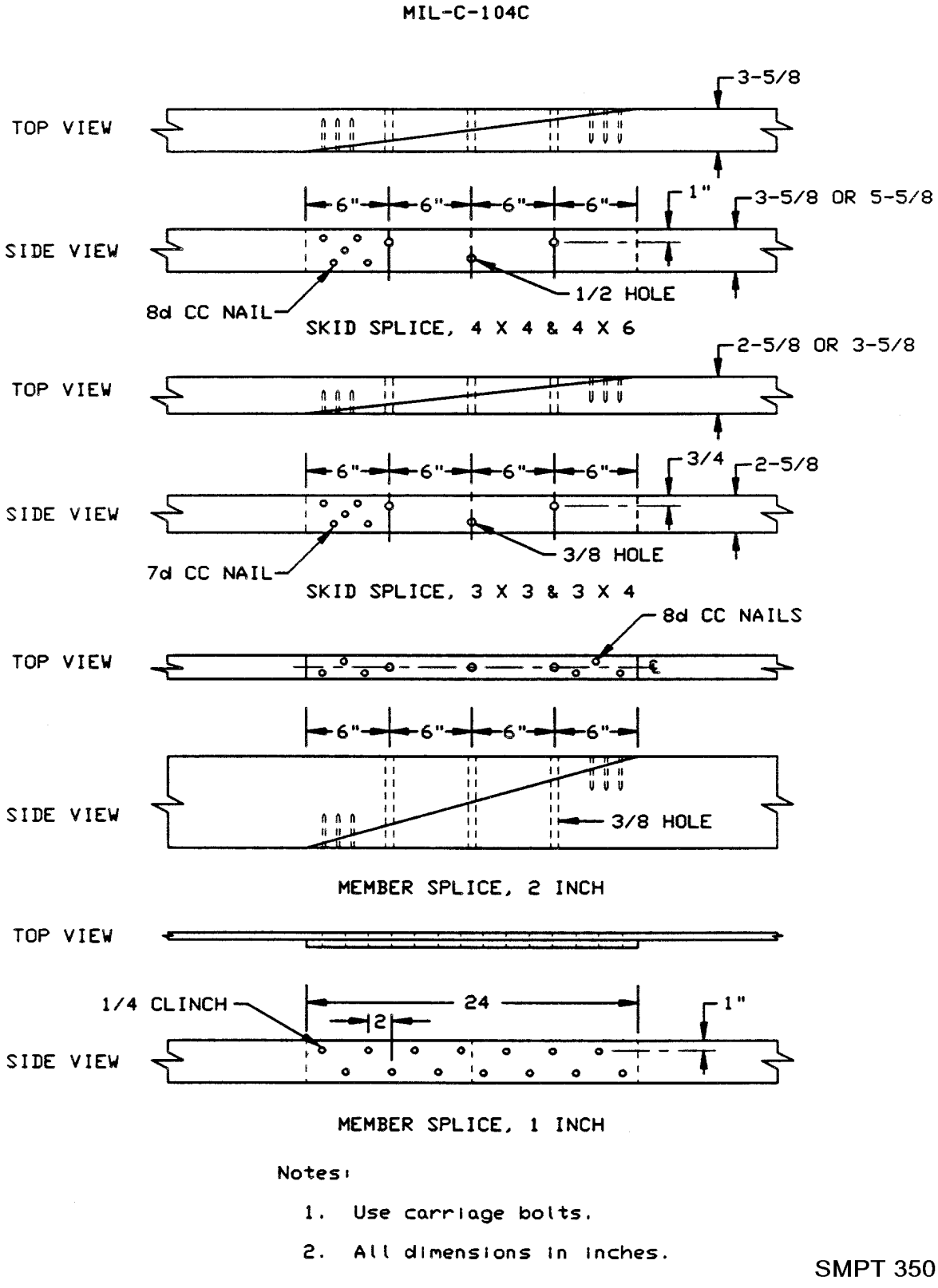
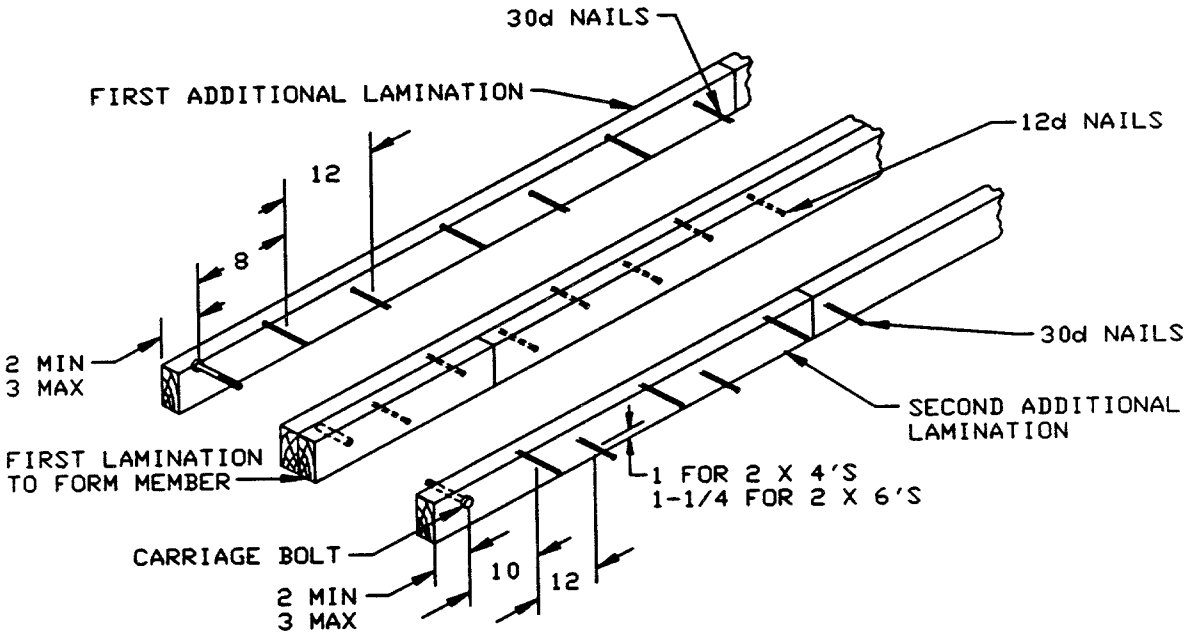
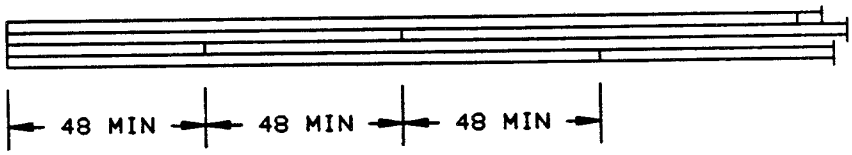


Figure 6-54. Splicing of members (MIL-C-104).

MIL-C-104C





STAGGERING JOINTS TOP VIEW

LAMINATION OF SKID OR SILL MEMBERS
(2 INCH THICK MATERIAL)

Note:

1. All dimensions in inches.

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Figure 6-55. Lamination of skid or sill members (MIL-C-104).

Table 6-28. Required header sizes and carriage bolt sizes

Skid size (in.)	Header size (in.)	Bolt Diameter (in.)
2 X 4	2 X 4 1/	3 8
3 X 3	3 X 3	3/8
3 X 4		
4 X 4	4 X 4	1/2
4 X 6		

1/ For nailed crates only in width to 48 inches. For wider crates or bolted crates, use 3X3.

Rubbing Strip for Skids

Rubbing strips of 3-inch thick lumber, the same width as the skids, shall be attached to the skids with two staggered rows of nails spaced 12 inches apart in each row The nails shall be driven through the rubbing strip into the skid, shall be of such length as to penetrate a minimum of approximately 70 percent of the skid thickness, and shall not protrude through the skid. The strips shall be beveled full depth at an angle of 45 degrees at sling and forklift openings. Openings in the rubbing strips for forklift-truck access shall be 12 inches in length, 28 inches center to center, and positioned to straddle the center of balance of the loaded crate. Sling openings not less than 4 inches in length, and preferably 8 inches, shall be provided at the ends of the rubbing strip where permitted by the length of the crate and by the location of the forklift-truck access openings. No center pieces of the rubbing stirps shall be less than 16 inches in length. On crates 5 feet and less in length, the forklift openings shall be omitted; end sling openings shall not be less than 6 inches long and shall serve as both forklift and sling openings.

Headers

Headers shall be placed at each end of the base and shall be bolted to each skid with one carriage bolt. Sizes of headers and bolts shall be as shown in table 6-28.

Forklift Members

The forklift members shall consist of the header and two members of equal size, spaced 20 to 40 inches (on center) from each end of the skids and bolted as shown in figure 6-52. Where the form of the item to be crated makes it impractical to use these members, or when crates are short or narrow, 2 inch-thick lumber shall be used in the 48-inch end areas as shown in figure 6-52. When 2-inch lumber is used in the forklift area and intermediate skids are required because of the width of the base, the 2-inch forklift members shall be bolted to the intermediate skids. Forklift members shall be notched or set back a specified for headers. If loaded containers center of balance is other than the center of the base, the space for forklift entry shall be positioned so that the center of balance is centered in between forklift openings.

Headers shall be of a single piece and not built up to two or more pieces to meet the dimension requirements. Headers shall be placed atop the plywood when plywood flooring is used. Headers shall be placed a distance back from the ends of the skids equal to the thickness of the end sheathing. The ends of the headers shall be notched for bases floored with lumber; ends of headers for plywood floored bases shall be set back from the outside edges of the outer skids (see figures 6-52 and 6-53). The notched and set back distances shall be equal to the thickness of the lower frame members of the skids.

Load-bearing Floorboards

Load-bearing floorboards shall be placed where the concentrated loads of the contents occur. The cross section shall be determined from table 6-29. The forklift members and any 1 or 2 inch flooring may be considered as load-bearing within limits of their assigned values. The ends of load-bearing floorboards shall be notched or set back from the edge of the base in the same manner as described for headers (see figures 6-52 and 6-53). Load-bearing floorboards 4 inches wide shall be bolted to each skid with one carriage bolt, and load-bearing floorboards over 4 inches wide shall be bolted to each skid with two carriage bolts, and the intermediate skid where one is required. Bolt diameters shall be the same as specified for corresponding skid sizes.

Lumber Flooring

Lumber floorboards shall be neither less than 1 inch thick not less than 4 inches wide, and shall be placed at right angles to the skids. Boards shall be spaced 1/4 inch apart for drainage and the ends placed flush with the outside face of the skids. When a large area of the base is floored with 2-inch thick lumber, the use of filler strips 2 inches wide shall be used along each side over he thinner flooring to equal the thickness of the 2 inch flooring as shown in figure 6-53. The filler strips shall be nailed to the flooring with two staggered rows of sixpenny nails spaced 10 inches apart. Nailing of floorboards to skids shall be as shown on figure 6-50.

Plywood Flooring

Plywood 3/8 inch in thickness, may be used in place of 1 inch lumber flooring as shown in figures 6-52 and 6-53, but not as load-bearing floorboards. Plywood flooring shall be laid flush with the outer edges of the skids and with the face grain perpendicular to the skid length. Headers and load-bearing floorboards shall be placed on top of the plywood and bolted to the skids after the plywood has been nailed in place. Plywood flooring shall be nailed to each skid with two rows of sevenpenny nails, staggered and spaced 6 inches apart in each row. A spacing of 1/4 inch shall be allowed between sheets of plywood for drainage. When 1/3 to 1/2 the area of the base is floored with 2 inch boards, the plywood flooring shall be used only between these areas. Filler strips shall be nailed over the plywood as shown on figure 6-51 with nailing as specified.

Drainage

A drainage hole, 1/2 inch in diameter, shall be drilled next to each header or load-bearing member in each outer edge of plywood floored section of the base. Holes should not be covered with contents are placed on the base of the crate.

Sill Type (Style b)

Style b bases shall be constructed as shown in figure 6-56. The load contained on Style b bases shall always be transmitted to the side sills by means of intermediate sills or by the article itself.

Side and End Sills

The size of the side sills shall be determined from table 6-30. End sills shall be of the same size as side sills. The side sills shall overlap the end sills as shown in figure 6-56. Sills shall be laminated as shown in figure 6-55, when necessary.

Intermediate Sills and Load-bearing Headers

Intermediate sills shall be applied crosswise of the base. The size of intermediate sills shall be determined from table 6-31. The weight used to determine the size of an intermediate sill shall be that amount of the load actually supported by that sill. Load-bearing headers shall be of the same size as intermediate sills. Load-bearing headers and intermediate sills will not be required when all of the load is supported by the side sills. Load-bearing headers shall be attached at their ends to intermediate sills and intermediate sills shall be attached at their ends to side sills by a combination of nailing and the use of metal strap hangers fabricated from 1-1/4 inches wide by 0.035 inch thick nail-on strapping as shown in figure 6-57.

Bridging

Intermediate sills shall be bridged at the ends with 1-inch lumber and at intervals along the span not exceeding 4 feet with 2-inch lumber of the same depth as the intermediate sills (see figure 6-56).

Table 6-29. Allowable load in lb per inch of floorboard width groups I and II woods

Distance between skids (in.)	Thickness of load-bearing floorboard (in.)					
	3/4	1-1/2	2-2/2	3-1/2	5-1/2	7-1/2
12	57	287	600	1170	2900	5000
18	38	191	400	780	1930	3350
24	29	143	300	590	1400	2500
30	23	115	240	470	1160	2000
36	19	95	200	390	960	1680
42	16	82	170	335	830	1440
48	14	71	150	290	720	1250
54	12	63	030	260	645	1120
60	11	57	120	234	580	1000
66	10	52	110	212	525	910
72	9	48	100	195	480	840
84	8	41	85	140	360	710
96	8	35	75	167	300	630
108	7	34	66	130	233	560
120	7	30	60	117	210	500

Table 6-30. Nominal size of side sills (in.)*

Gross weight of crate (lb.)	Length of crate (ft.)							
	4	8	12	16	20	24	28	32
to 2,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 4	2 X 6	2 X 6	2 X 6
2,001 - 4,000	2 X 4	2 X 4	2 X 4	2 X 4	2 X 6	2 X 6	2 X 6	2 X 8
4,001 - 6,000	2 X 4	2 X 4	2 X 4	2 X 6	2 X 6	2 X 6	2 X 8	2 X 8
6,001 - 8,000	.....	2 X 4	2 X 6	2 X 6	2 X 6	2 X 8	2 X 8	2 X 8
8,001 - 10,000	.....	2 X 6	2 X 6	2 X 6	2 X 6	2 X 8	2 X 8	2 X 10
10,001 - 12,000	.....	2 X 6	2 X 6	2 X 8	2 X 8	2 X 8	2 X 10	2 X 10
12,001 - 14,000	.....	2 X 6	2 X 8	2 X 8	2 X 8	2 X 10	2 X 10	2 X 10
14,001 - 16,000	.....	2 X 8	2 X 8	2 X 8	2 X 10	2 X 10	2 X 10	2 X 8
16,001 - 18,000	.....	2 X 8	2 X 8	2 X 10	2 X 10	2 X 10	2-2 X 8	2-2 X 8
18,001 - 20,000	.....	2 X 8	2 X 10	2 X 10	2 X 10	2-2 X 8	2-2 X 8	2-2 X 8

* The above sizes are for crates with a height of 3 feet or less. For heights of over 3 feet, increase 2X4 sizes to 2X6; increase 2X6 to 2X8; increase 2X8 to 2X10; and increase 2- 2X8 to 2- 2X10.

Table 6-31 Allowable load for intermediate sills (in lb per inch of sill width)

Length of sill (ft)	Sill depth (inch) Groups I and II woods						
	1-1/2	2-1/2	3-1/2	5-1/2	7-1/2	9-1/2	11-1/2
4	71	150	290	720	1,250	2,000	3,000
5	57	120	234	580	1,000	1,640	2,400
6	48	100	195	480	840	1,320	2,020
7	41	85	167	399	710	1,170	1,730
8	35	75	140	350	630	1,020	1,500
9	34	66	130	300	560	910	1,350
10	30	60	117	270	500	820	1,200

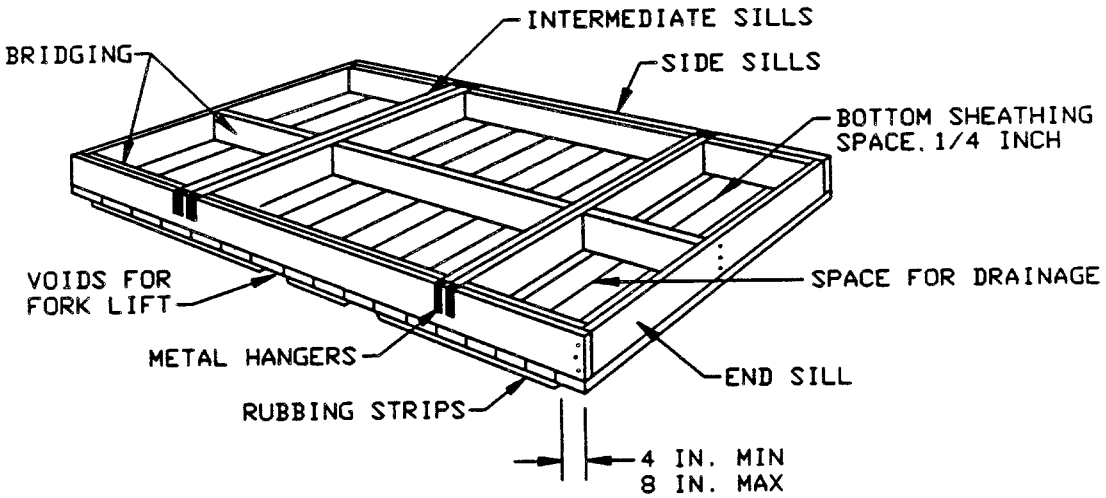
Bottom Sheathing

Style b bases shall be sheathed on the bottom with lumber securely nailed to the bottom surface of the sills at right angles to the direction of the side sills. Boards shall be 4 to 10 inches wide and of not less than 1 inch material for spans of less than 30 inches between longitudinal members and of not less than 2-inch material for spans of 30 inches or more. Bottom sheathing shall be flush with the outside face of all side and end sills and be spaced 1/4 inch apart fro drainage. One-inch boards shall be nailed with eightpenny nails, 2 inch boards with twelvepenny nails, and nailing shall be as shown in figure 6-50.

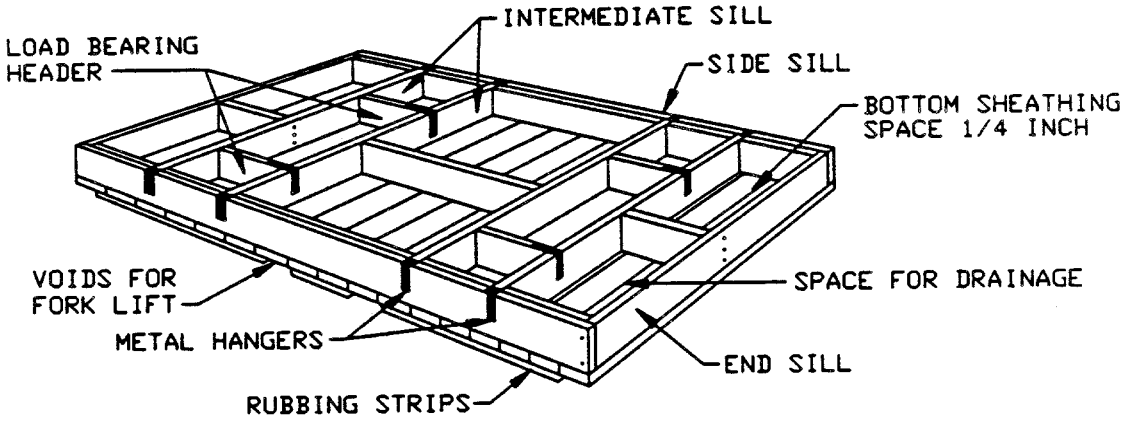
Rubbing strips

Style b bases shall have rubbing strips 3 inch thick material, the width of which shall not be less than 4 inches. The rubbing strips shall always be applied lengthwise of the base and positioned under each longitudinal member. When require, intermediate rubbing strips of the same size are located so that the clear distance between rubbing strips does not exceed 36 inches.

MIL-C-104C



SILL BASE WITH DOUBLED SILLS



SILL BASE WITH LOAD-BEARING HEADERS

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Figure 6-56. Sill bases (MIL-C-104).

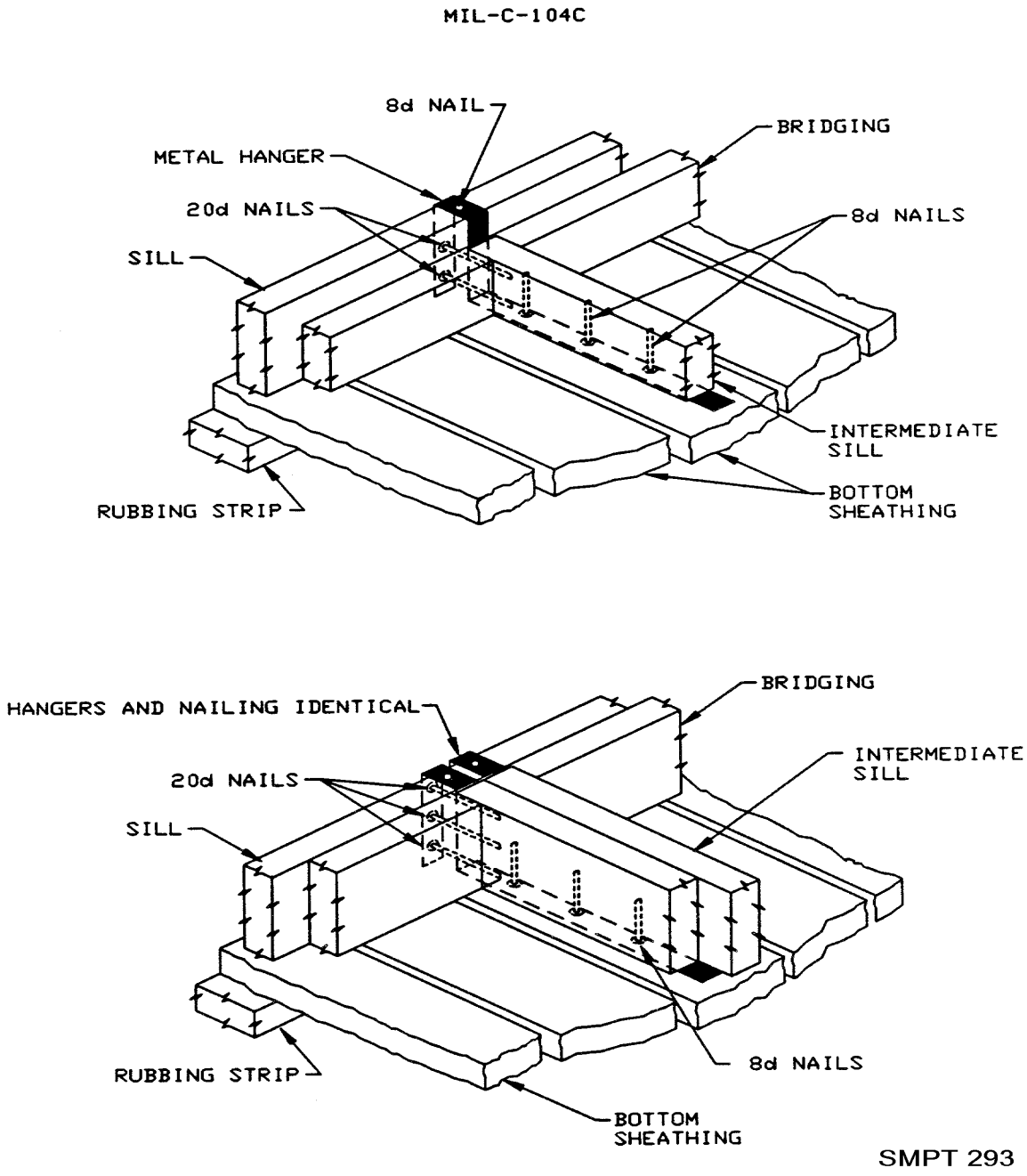


Figure 6-57. Attaching intermediate sills to side sills (MIL-C-104).

Tops

Tops shall be double sheathed and shall be

- narrow, widths through 54 inches;
- intermediate, widths over 54 inches through 60 inches;
- wide, over 60 through 120 inches in width.

Plywood sheathing 1/4 inch thick, shall be attached to the lumber framing with its face grain parallel with the width of the top and its edges flush with the outside edges of the framing. All joints of the plywood sheathing shall be made over joists or other frame members. Roofing felt, or polyethylene film

not less than 4 mils thick, shall be applied over the plywood with a minimum 4-inch overlap at joints. A nonhardening caulk or mastic shall be applied in the overlap area. Top sheathing boards not less than 4 inches wide shall be placed over the plywood sheathing and waterproof barrier and shall extend beyond the outer edges of the top framing by an amount equal to the thickness of side and end panel sheathing less 1/8 inch. Headers joining the joists together shall be 1 inch thick by the depth of the joists for intermediate and wide tops.

Narrow Tops

Narrow tops shall be framed on 2 X 4 inch members as shown in figure 6-58. Top sheathing board shall be applied parallel to the width of the top and shall be of single pieces. At plywood joints on the inside of the top, 2 X 3 inch pieces shall be used as shown in figure 6-58.

Intermediate Tops

Intermediate tops shall be framed on 2-inch joists placed flat and headers 1 inch by the thickness of the joists. The top sheathing boards shall be placed parallel to the length of the top (see figure 6-59). When the crate length is over 10 feet, end joints will be permitted in top sheathing board. All joints shall be made over joists, two joints shall be adjacent to each other, and not more than one-third of the joints shall be made over any one joist.

Wide Tops

Wide tops shall be constructed similar to intermediate tops except that the wide tops shall be framed in joists and headers placed on edge as shown in figure 6-60.

Fabrication Nailing

Fabrication nailing of tops shall be as shown in figures 6-61 and 6-62. All plywood members shall be nailed on at least three edges.

Alternate Plywood Sheathed Top

For tops not exceeding 96 inches wide, single sheathing of 1/2-inch thick plywood may be used in lieu of the double sheathed top. Face grain of the plywood shall be parallel with the width of the top. When joists do not coincide with plywood joints, a joint cover of 1 X 4 inch lumber shall be used on the inside of the top. Prior to securing the plywood to the joists or joint covers, caulking of a nonhardening type shall be applied at three places at each joint - between the plywood panels at their butt joint, and between the plywood and joint cover or joist on either side of the butt joint. The caulk shall be applied as a continuous bead and may be either performed or applied with a gun.

Sides

Number and Type of Panels

Sides shall be constructed as shown in figures 6-63, 6-64, and 6-65. In crates with style b bases, the sheathing of sides and ends shall reach below the lower horizontal frame member a distance equal to the depth of the sills plus floor thickness, less 1/8 inch. The type of side panels shall vary with the inside crate height as specified in table 6-32. The number of panels for each full length side shall be computed by dividing the inside crate length by the inside height, and using the nearest whole number.

Member Selection

The sizes of the upper and lower frame members, struts, and diagonals shall be determined from tables 6-34 to 6-43 except as otherwise specified. Loads referred to in the tables are the net loads and the dimensions are the inside measurements of the crate. The member sizes shall be based on Group II woods. If the exact size of the crate is not given in the tables, member sizes for the crate of the next greater length and width, and the next smaller height shall be used.

Upper and Lower Frame Members

Except where vertical joist supports are required, upper frame members for crates over 54 inches wide shall always be 2 inches thick and a minimum of 2 X 4 inches in size. Splicing of upper or lower frame members shall be done over or under a strut and shall be as shown in figure 6-64.

Vertical Struts

Vertical struts shall be continuous from the lower frame member to the upper frame member and the diagonal and horizontal braces shall be cut in between. The end struts shall be as shown in table 6-33.

Horizontal braces

Horizontal braces for Types B and C panels (figures 6-64 and 6-65) shall be the same thickness as the struts and 4 inches wide.

Diagonals

Size of diagonals shall be as specified in the member selection tables 6-34 to 6-43 and shall be located as shown in figures 6-63, 6-64 and 6-65. When frame members are 1 inch thick, gusset plates shall be cut from 1/4-inch plywood and shall be 12 inches minimum, in the shortest dimension. The corners shall coincide with the center line of the diagonals as shown in figure 6-65.

Joist Supports

The upper frame members shall serve as supports for tops. When crates are 6 feet wide and 12 feet high or 8 feet wide and 10 feet high (tables 6-34 to 6-43) and when the struts are 1 inch thick, vertical joist supports shall be provided as shown in figure 6-66. These shall consist of 2 by 4 inch members placed on and nailed to the frame members of the side and extending under each interior joist to the floor.

Table 6-32. Side panel types - class 1 crates

Inside height of crate (in.)	Type of panel	Reference figure No.
Over 24 to 60	A	13
Over 60 to 108	B	14
Over 108 to 144	C	15

Table 6-33. End strut requirements

Net load (lb.)	Nominal size of end struts	
	Bolted crate (in.)	Nailed crate (in.)
1,000 or under	2 X 4	2 X 4
Over 1,000 but under 5,000	3 X 3	2 X 4
5,000 and over	4 X 4	2 X 4

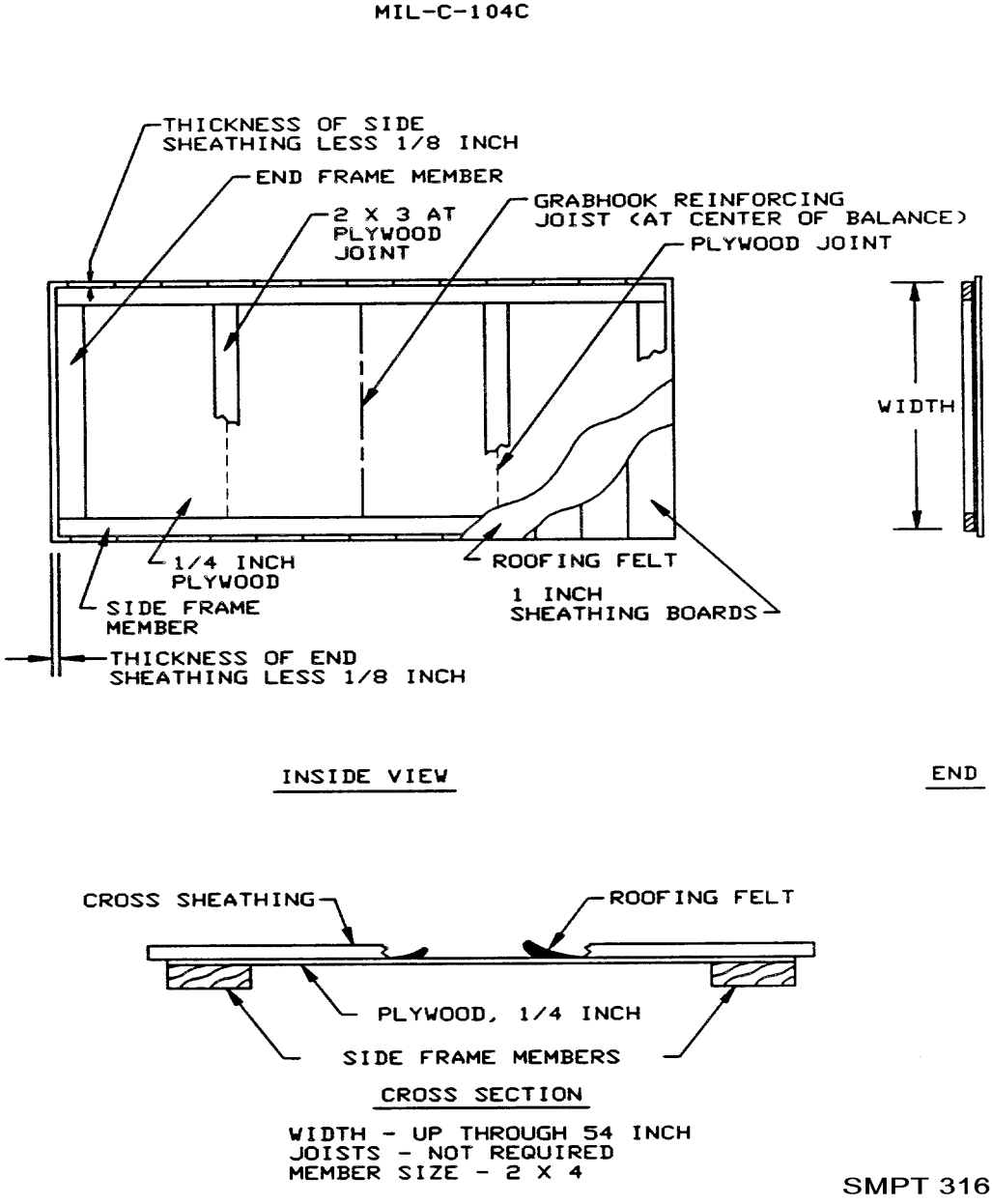


Figure 6-58. Narrow tops (widths up to 54 inches) (MIL-C-104).

MIL-C-104C

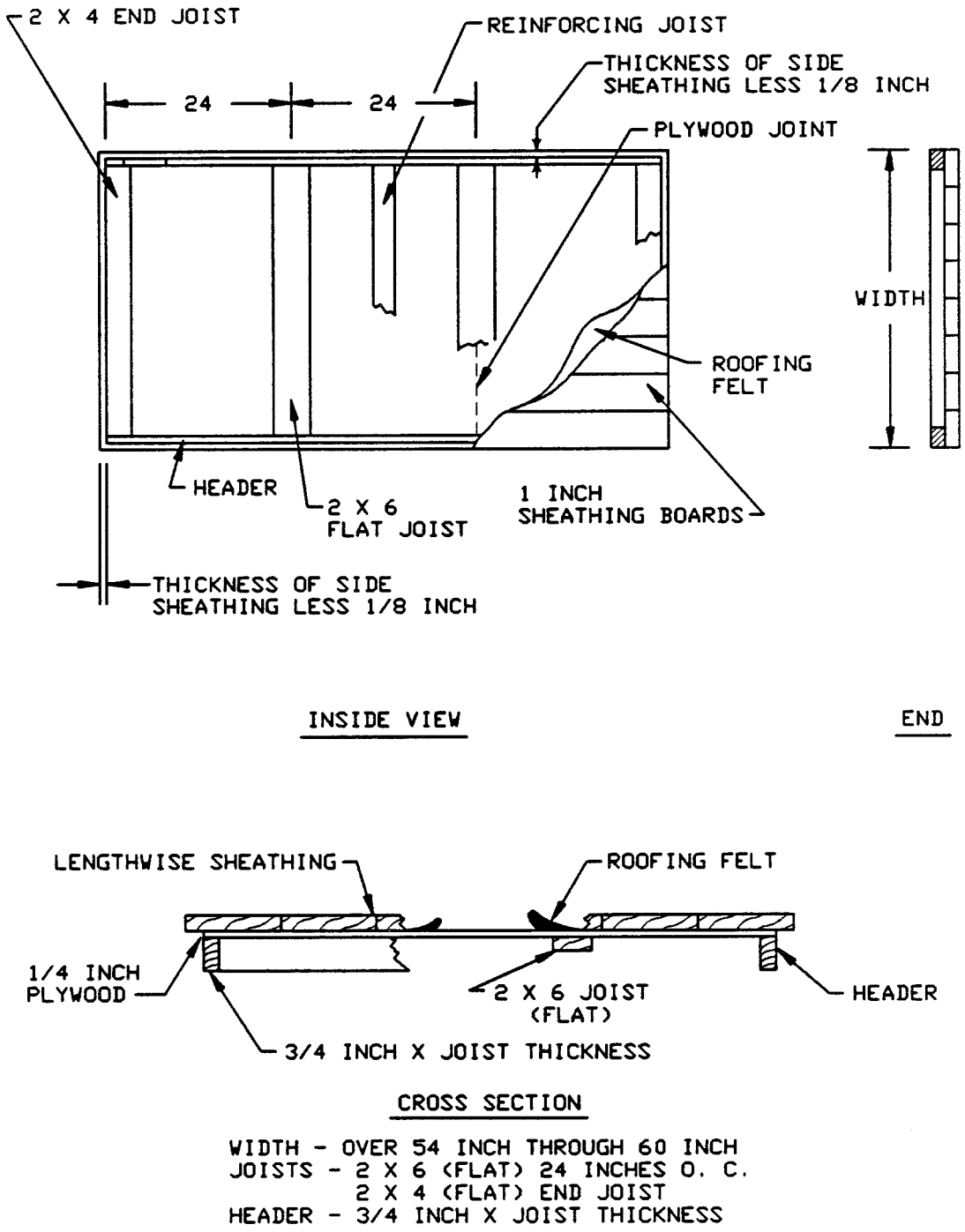
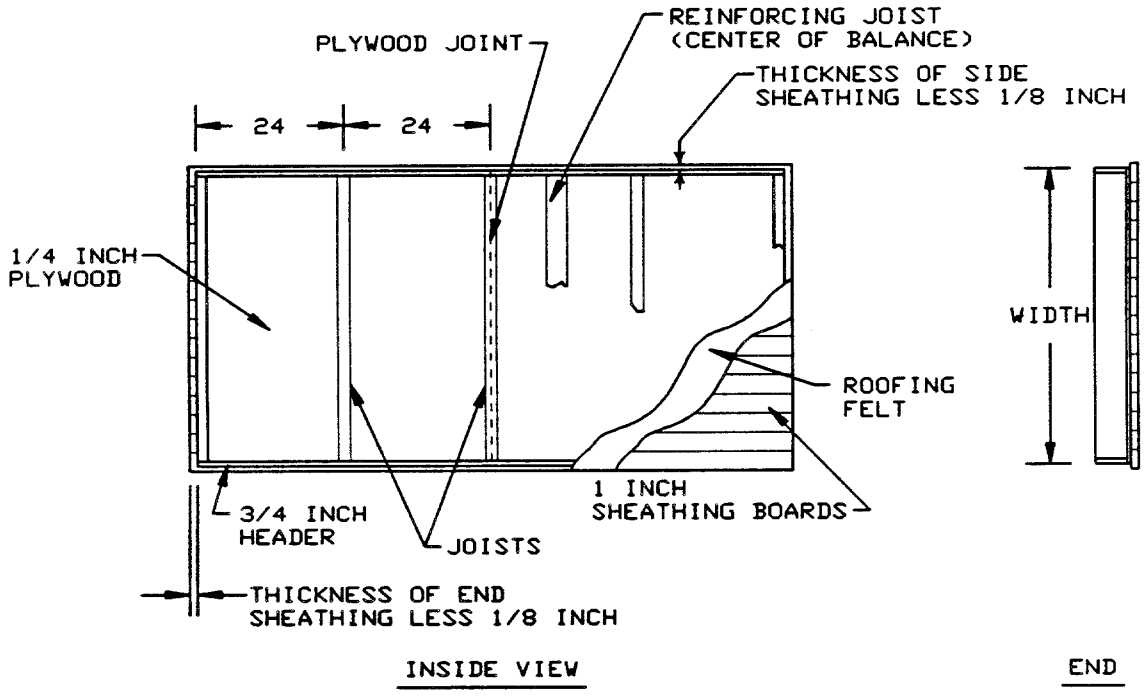
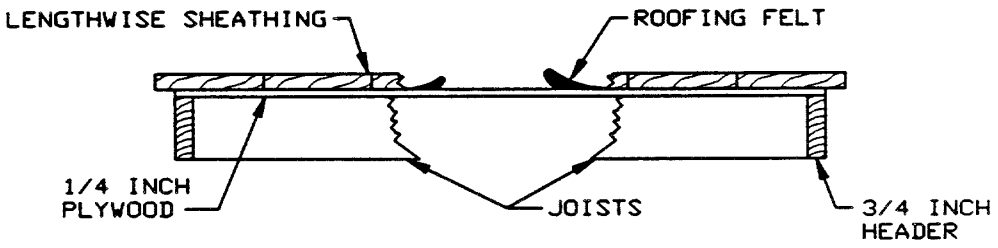


Figure 6-59. Intermediate tops (widths over 54 inches to 60 inches) (MIL-C-104).

MIL-C-104C





WIDTH - OVER 60 INCHES THROUGH 120 INCHES
JOISTS (SPACE 24 INCHES O. C.)

SPAN	SIZE
OVER 60 INCHES THRU 66 INCHES	2 X 4
OVER 66 INCHES THRU 78 INCHES	2 X 4 PLUS 1 X 4 OR 3 X 4 [1/]
OVER 78 INCHES THRU 90 INCHES	2 - 2 X 4 OR 4 X 4 [1/]
OVER 90 INCHES THRU 102 INCHES	2 X 6
OVER 102 INCHES THRU 120 INCHES	2 X 6 PLUS 1 X 6 OR 3 X 6 [1/]

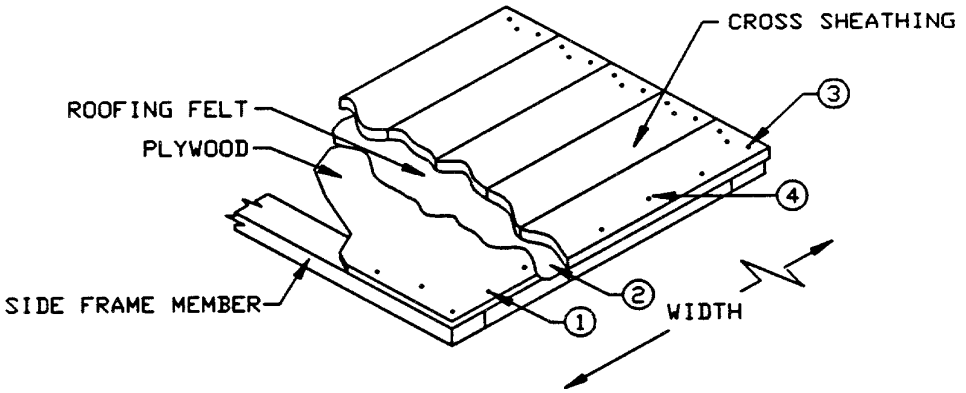
[1/] END JOIST TO BE SINGLE 2 INCH MEMBER AND SAME DEPTH AS JOISTS

HEADERS - 3/4 INCH THICK AND SAME DEPTH AS JOISTS

SMPT 328

Figure 6-60. Wide tops (widths over 60 inches to 120 inches) (MIL-C-104).

MIL-C-104C



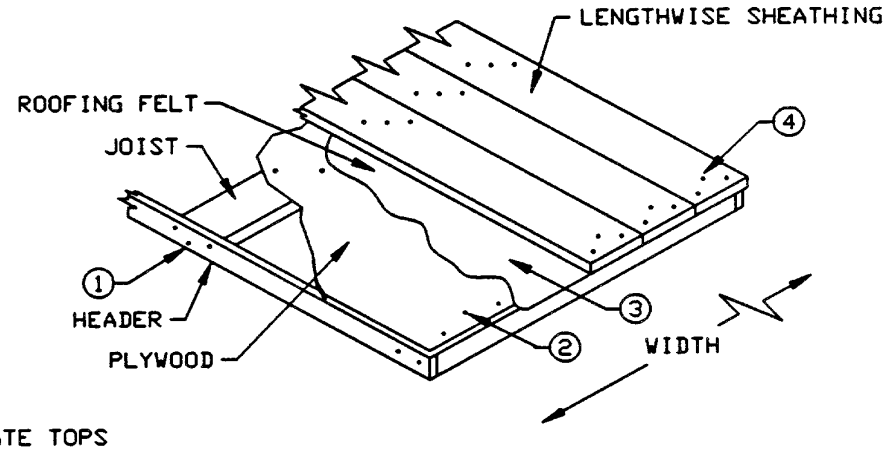
NARROW TOPS

① PLYWOOD TO FRAME MEMBERS
NAILS - 5d CEMENT COATED
SPACING - 8 INCHES O. C.

② ROOFING FELT - 4 INCH LAP AT JOINT - USE MASTIC

③ SHEATHING THROUGH PLYWOOD INTO FRAMING MEMBER
NAILS - 8d CEMENT COATED
SPACING - 3 INCHES O. C. (MINIMUM 2 PER BOARD)

④ AS ③ BUT SPACE 8 INCHES O. C.



INTERMEDIATE TOPS

① HEADER TO FLAT JOIST - 12d CEMENT COATED NAIL, SPACE 2 INCHES O. C.

② PLYWOOD TO JOIST AND HEADER - 5d CEMENT COATED NAIL, SPACE 8 INCHES O. C.

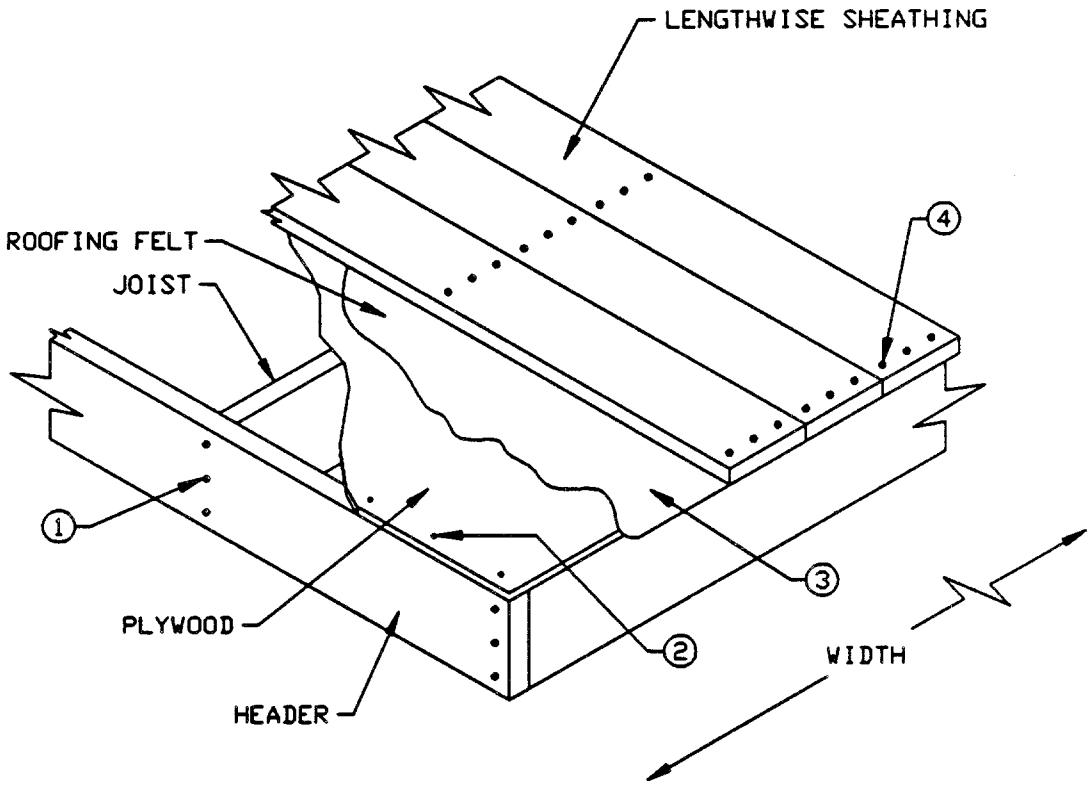
③ ROOFING FELT - 4 INCH LAP AT JOINT - USE MASTIC

④ SHEATHING INTO JOIST - 8d CEMENT COATED NAIL, SPACE 3 INCHES O. C.

SMPT 338

Figure 6-61. Fabrication of tops (narrow and intermediate) (MIL-C-104).

MIL-C-104C



WIDE TOPS

① HEADER TO JOIST - 12d cc NAIL
2 X 4's - 2 NAILS
2 X 6's - 3 NAILS

② PLYWOOD TO JOIST AND HEADER
5d cc NAIL - SPACE 8 IN. ON CENTER

③ ROOFING FELT - 4 IN. LAP AT JOINT - USE MASTIC

④ SHEATHING INTO JOIST - 8d cc NAILS
1 X 4, 1 X 6 - 2 NAILS PER JOIST
1 X 8, 1 X 10 - 3 NAILS PER JOIST

SMPT 339

Figure 6-62. Fabrication of tops (wide top) (MIL-C-104).

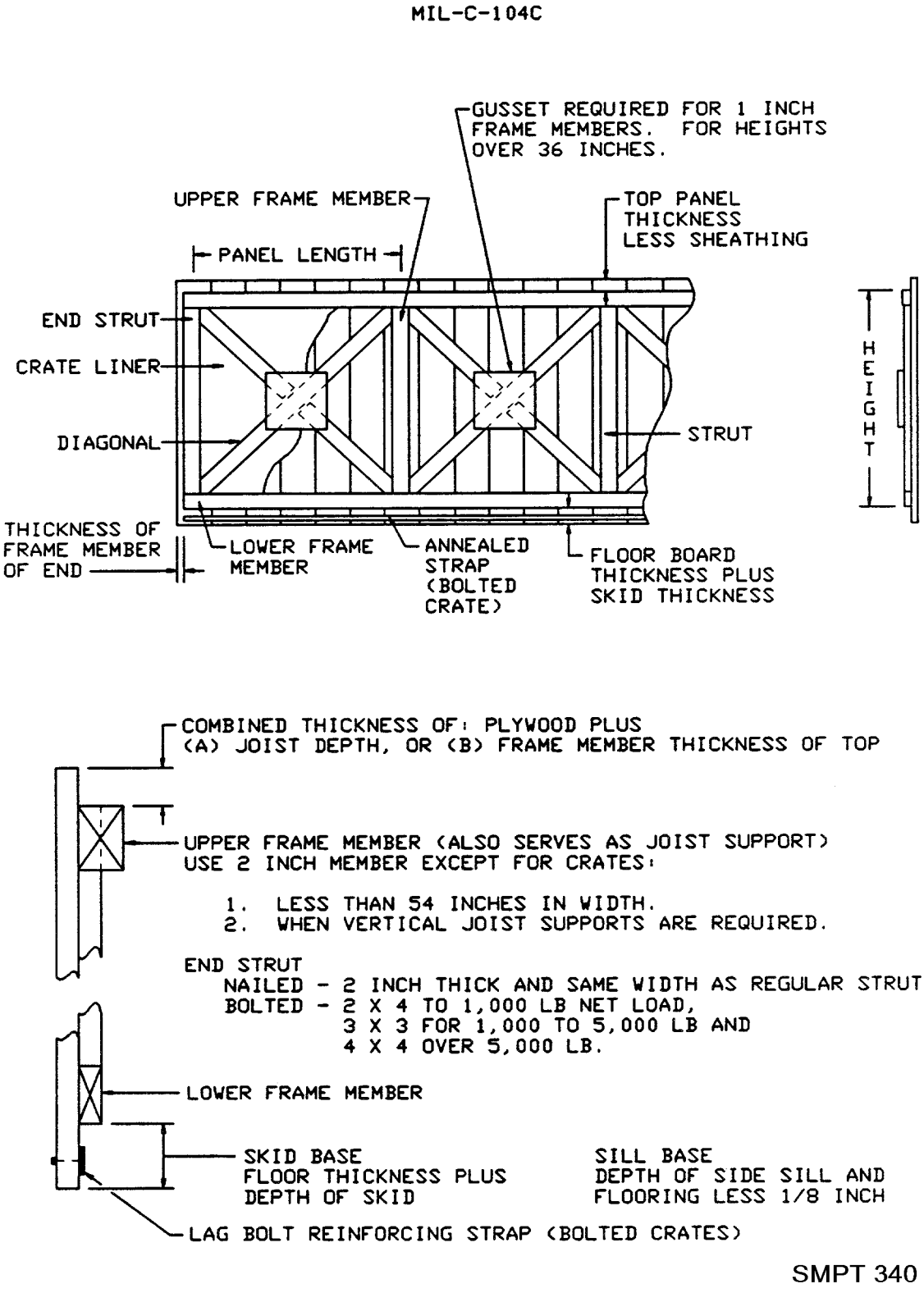


Figure 6-63. Sides type A panel (lumber) (heights over 24 inches to 60 inches) (MIL-C-104).

Liners

A crate liner shall be applied between the sheathing and frame members of sides and ends of all lumber-sheathed crates and shall conform to the crate liners specified in PPP-B-1055. The paper shall be placed horizontally as unrolled, with a 4-inch minimum shingle lap applied for proper drainage and shall cover the entire framed area. Vertical joints, when require, shall have a minimum 4-inch lap and shall be located at a vertical member.

Sheathing

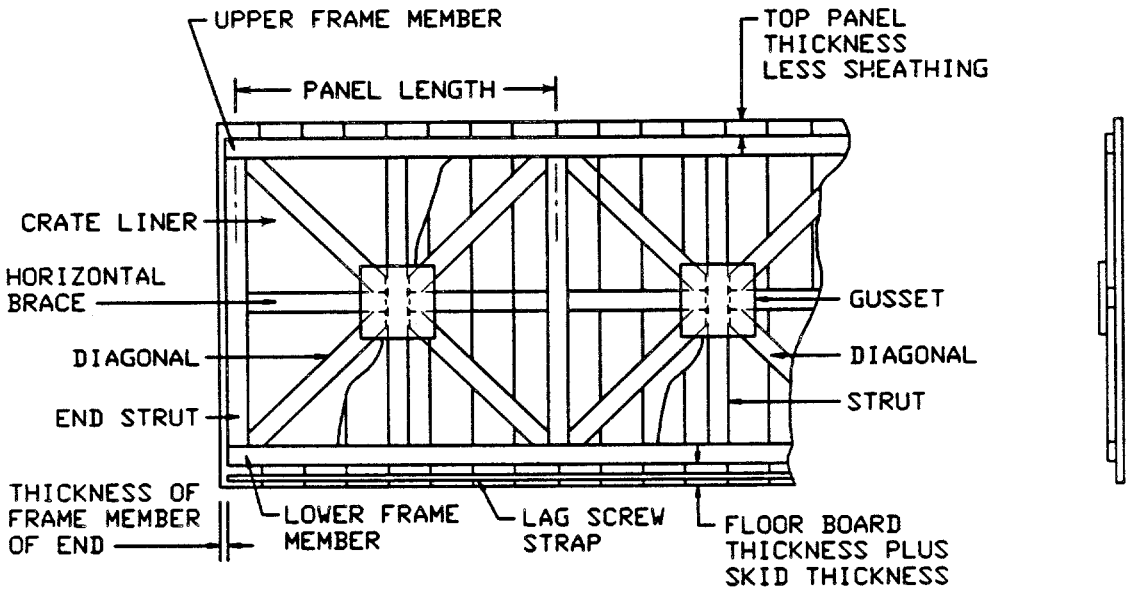
Sheathing for the side and end panels of crates shall be applied vertically, shall extend to the bottom of the skids one side panels and to the tops of skids on the end panels of skid type base crates. Sheathing shall extend to the bottom of sills on sill-type base crates. Sheathing shall be either tongue-and-groove or square and shall be 1 inch thick. At least one side of all boards shall be dressed and the dressed side placed outward. No boards shall be less than 4 inches in width. End boards shall be not less than 6 inches wide and preferably wider. No more than 10 percent of the boards (not more than one out of 10 boards) shall be of the minimum width, nor shall the narrow boards be adjacent to each other. Short boards, not less than 2 feet in length, may be used under the following conditions (figure 6-67):

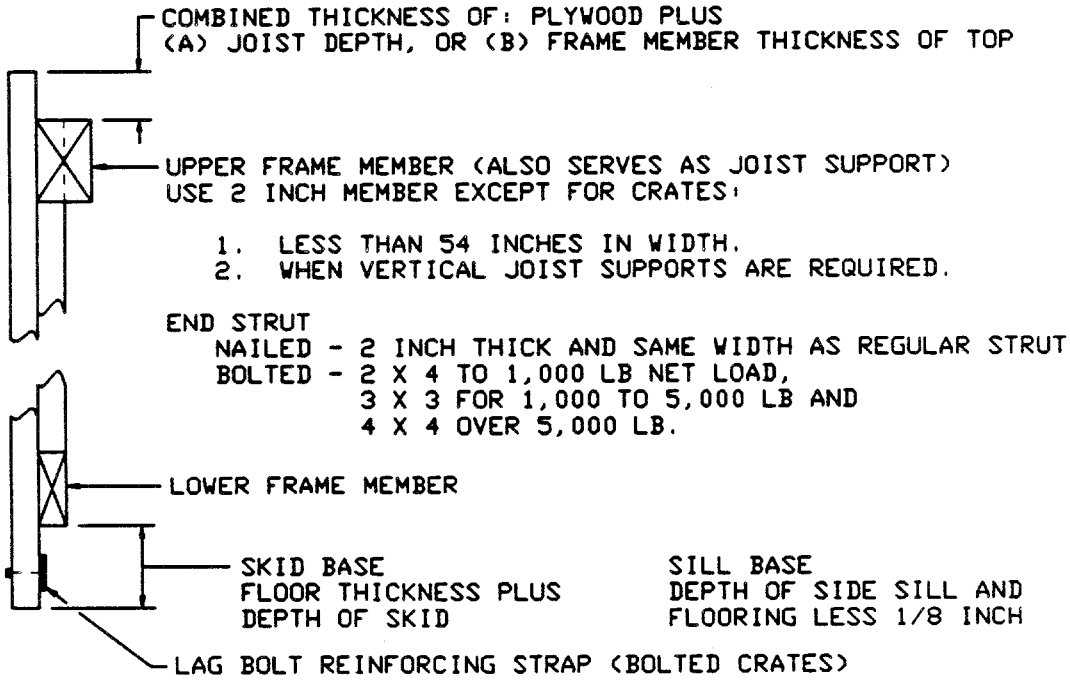
- boards shall be cut at right angles,
- the center of a short sheathing board shall be at the approximate center of the width of a diagonal and shall have full coverage by the diagonal, or shall be joined on a horizontal member,
- at least every second board and all end boards shall be full length, and
- nailing shall be as shown in figure 6-67.

Fabrication Nailing

Nails securing sheathing to framing up to and including 2 inch thickness shall be driven through the sheathing and shall be of such length as to permit a minimum of 1/4-inch clinch on the framing. For nailing sheathing to horizontal and diagonal frame members 4 to 6 inches wide, three rows of nails shall be used. There shall be a minimum of three nails per crossing in sheathing boards 4 to 6 inches wide and a minimum of four nails in wider boards (figure 6-67). For nailing sheathing to horizontal and diagonal frame members over 6 inches wide, four rows of nails shall be used. There shall be a minimum of four nails per crossing in sheathing boards 4 to 8 inches wide and a minimum of five nails in wider boards (figure 6-65). For nailing sheathing to struts 4 to 6 inches wide, two rows of nails shall be used. The nails shall be spaced approximately 8 inches apart in each row and staggered. For wider struts use three rows of nails. The nails shall be spaced approximately 12 apart and staggered. Nail spacing at vertical butt joints shall be as shown in figure 6-67. Gusset plates shall be secured with sevenpenny nails driven through and clinched on the sheathing. Nailing shall be shown in figure 6-66. Vertical joist supports shall be secured with two tenpenny nails at each horizontal frame member crossing and one tenpenny nails at each diagonal crossing as shown in figure 6-66. Where vertical joists coincide with struts, there shall be two rows of nails on 30 inch centers.

MIL-C-104C





SMPT 341

Figure 6-64. Sides type B panel (lumber) (heights over 60 inches to 108 inches) (MIL-C-104).

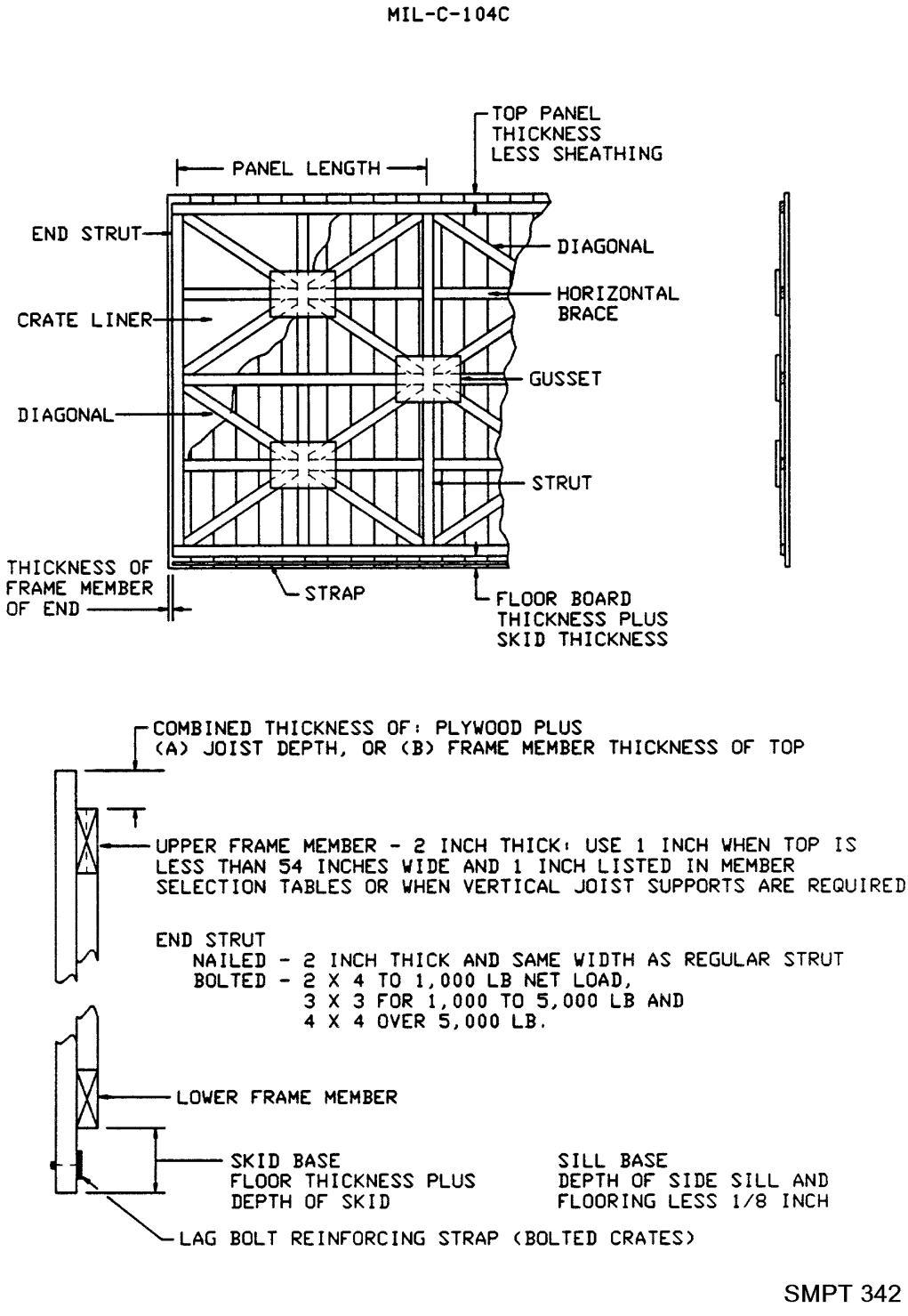


Figure 6-65. Sides type C panel (lumber) (heights over 108 inches to 144 inches) (MIL-C-104).

Lag Screw Reinforcing Strap for Bolted Crates

Reinforcing strap shall be used on side and end panels of all demountable crates as shown in figures 6-68, 6-69 and 6-70. Galvanized steel strap, punched or drilled, 1-1/4 inches by 0.035 inch of 3/4 inch lag screws, and 2 inches by 0.050 inch for 1/2 and 5/8 inch lag screws, shall be nailed to the inner face of the sheathing between the lower edge of the bottom frame member and the bottom of the sheathing as shown in figure 6-68. The strap shall be located to coincide with the center of the skid or header and shall be nailed on maximum 2 inch centers to the sheathing with clout or similar nails. Nails shall be clinched at least 3/8 inch.

Ends

End types and size of members for ends in crates over 30 inches wide shall be determined in a manner similar to the sides, except that in all cases the thickness of the upper and lower frame members shall be the same as the struts specified in tables 6-34 to 6-43. The member arrangement shall conform, to the details shown in figure 6-81. For crates less than 30 inches wide, single diagonals only are required and all frame members shall be 1 by 4 inches in size as shown in figure 6-81.

ASSEMBLY (CLASS 1 CRATES)

BOLTED CRATE

General

Type II (bolted) crates shall be assembled with lag bolts. Lead holes shall be used for lag bolts.

Fastening Sides to Base

The sides shall be secured to the skids with lag bolts. For 3 X 4 inch skids, 3/8 inch diameter by 3-inch long lag bolts shall be used; for 4 X 4 inch skids, 1/2 inch diameter by 4 inch long lag bolts shall be used. The number of lag bolts shall be as specified in table 6-44. One-half the number shall be used on each side and the spacing shall be uniform along the skid. Maximum spacing shall be 16 inches for 3/8-inch lag bolts and 20 inches for 1/2 inch lag bolts. Lead holes shall be drilled in line with and through the center of the metal reinforcing strap, as well as through the sheathing and into the skid. Assembly and placement details shall be as shown on figures 6-71 and 6-72.

Fastening Sides to Top

Lag bolts, 3/8 inch diameter by 3-1/2 inches long, shall be used to fasten the sides to the top. These lag bolts shall be placed so that there is one in the end of each joist at the approximate center (figure 6-73). For tops without joists, lag bolts shall be placed at the approximate center of the side frame member of the top and spaced no greater than 24 inches apart.

Fastening Ends to Top, Sides, and Base

Lag bolts for fastening ends to tops shall be 3/8 inch in diameter by 2-1/2 inches long. Lag bolts for fastening ends to sides shall be 3/8 inch diameter by 3-1/2 inches long. Placement and other assembly details shall be as shown in figure 6-71 and 6-73. Lag bolts for fastening ends to base shall be the same size. Location and spacing shall be as shown in figures 6-71 and 6-72. Lead holes shall be centered on the reinforcing strap.

Table 6-34. Panel member selection table for 1,000 lb. net load*

Note. All blank spaces are 1X4s

Length (ft.)	Member	4 foot width Height (ft.)						6 foot width Height (ft.)						8 foot width Height (ft.)						10 foot width Height (ft,.)					
		2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
6	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																	2x4						2x4	2x4
	Struts																	2x4						2x4	2x4
	Diagonal																								
8	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																	2x4						2x4	2x4
	Struts																	2x4					1x6	2x4	2x4
	Diagonal																								
10	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																	2x4						2x4	2x4
	Struts																	2x4					1x6	2x4	2x4
	Diagonal																								
12	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																	2x4						2x4	2x4
	Struts																	2x4					1x6	2x4	2x4
	Diagonal																								
16	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																	2x4						2x4	2x4
	Struts																1x6	2x4			1x6		1x6	2x4	2x4
	Daigonal																								
20	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																	2x4						2x4	2x4
	Struts																1x6	2x4			1x6		1x8	2x4	2x4
	Diagonal																						1x6		1x6
24	Upper frame	1x6						1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4	2x4
	Lower frame																	2x4						2x4	2x4
	Struts	1x6						1x6			1x6			1x6	1x6		1x6	2x4		1x6	1x6		1x8	2x4	2x4
	Diagonal	1x6						1x6						1x6			1x6			1x6			1x6		1x6
28	Upper frame	1x6						1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4	2x4
	Lower frame																	2x4					2x4	2x4	2x4
	Struts										1x6			1x6	1x6		1x8	2x4		1x6	1x6		2x4	2x4	2x4
	Diagonal	1x6						1x6						1x6			1x6	1x6		1x6			2x4	1x6	1x4
32	Upper frame	1x6						1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4	2x4
	Lower frame																2x4	2x4					2x4	2x4	2x4
	Struts										1x6			1x6	1x6		2x4	2x4		1x6	1x6	1x6	2x4	2x4	2x4
	Diagonal	1x6		1x6				1x6			1x6	1x6		1x6			2x4	2x4		1x6		1x6	2x4	2x4	2x4

*Crates 12 feet high in 8-foot widths and crates 10 feet high in 6-foot widths require 2x4 vertical joists supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

Table 6-35. Panel member selection table for 2,000 lb. net load

Note. All balnk spaces are 1x4s.

		4 foot width						6 foot width						8 foot width						10 foot width					
Length		Height (ft.)						Height (ft.)						Height (ft.)						Height (ft,.)					
(ft.)	Member	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
6	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																		2x4					2x4	2x4
	Struts																		2x4					2x4	2x4
	Diagonal																								
8	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																		2x4					2x4	2x4
	Struts																		2x4				1x6	2x4	2x4
	Diagonal																								
10	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																		2x4					2x4	2x4
	Struts																		2x4				1x6	2x4	2x4
	Diagonal																1x6						1x6		
12	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																		2x4					2x4	2x4
	Struts																		2x4				1x6	2x4	2x4
	Diagonal																						1x6		
16	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																		2x4					2x4	2x4
	Struts																1x6		2x4		1x6		1x6	2x4	2x4
	Diagonal																1x6						1x6		1X6
20	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																		2x4				2x4	2x4	2x4
	Struts																1x6		2x4		1x6		2x4	2x4	2x4
	Diagonal																1x6		1x6				2x4		1x6
24	Upper frame	1x6						1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4		2x4	1x6	2x4	2x4	2x4	2x4	2x4
	Lower frame																2x4		2x4				2x4	2x4	2x4
	Struts	1x6						1x6			1x6			1x6	1x6		2x4		2x4	1x6	1x6		2x4	2x4	2x4
	Diagonal	1x6						1x6			1x6			1x6			2x4		1x6	1x6			2x4	1x6	2x4
28	Upper frame	1x6						1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4		2x4	1x6	2x4	2x4	2x4	2x4	2x4
	Lower frame																2x4		2x4				2x4	2x4	2x4
	Struts	1x6						1x6			1x6			1x6	1x6		2x4		2x4	1x6	1x6		2x4	2x4	2x4
	Diagonal	1x6						1x6			1x6		1x6	1x6			2x4		2x4	1x6			2x4	1x6	2x4
32	Upper frame	1x6	1x6		2x4			1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4		2x4	1x6	2x4	2x4	2x4	2x4	2x4
	Lower frame				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Struts	1x6			2x4			1x6			2x4			1x6	1x6		2x4		2x4	1x6	1x6	1x6	2x4	2x4	2x4
	Diagonal	1x6			2x4			1x6			2x4		1x6	1x6			2x4	1x6	2x4	1x6		1x6	2x4	2x4	2x4

*Crates 12 feet high in 6-foot widths and crates 10 feet high in 8-foot widths require 2x4 vertical joists supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

Table 6-36. Panel member selection table for 4,000 lb. net load

Note. All balnk spaces are 1x4s.

		4 foot width						6 foot width						8 foot width						10 foot width					
Length		Height (ft.)						Height (ft.)						Height (ft.)						Height (ft,.)					
(ft.)	Member	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
6	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																		2x4					2x4	2x4
	Struts																		2x4					2x4	2x4
	Diagonal																						1x6		
8	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																		2x4					2x4	2x4
	Struts																		2x4				1x6	2x4	2x4
	Diagonal										1x6						1x6						1x6		1x6
10	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																2x4		2x4				2x4	2x4	2x4
	Struts																2x4		2x4				2X4	2x4	2x4
	Diagonal				1x6						1x6						2x4						2X4		
12	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																		2x4				2x4	2x4	2x4
	Struts																		2x4				2x4	2x4	2x4
	Diagonal				1x6						1x6						1x6						2x4		1x6
16	Upper frame	1x6						2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Lower frame																2x4		2x4				2x4	2x4	2x4
	Struts																2x4		2x4		1x6		2x4	2x4	2x4
	Diagonal				1x6						1x6						2x4		1X6				2x4		1x6
20	Upper frame	1x6						2x4	2x4	2x4	2x4	2X4		2x4	2x4	2x4	2x4		2x4	2x6	2x4	2x4	2x4	2x4	2x4
	Lower frame																2x4		2x4				2x4	2x4	2x4
	Struts																2x4		2x4		1x6		2x4	2x4	2x4
	Diagonal				1x6						1x6						2x4		1x6		1x6		2x4	1x6	1x6
24	Upper frame	1x6	1x6					1x6	1x6	2x4	2x4	2x4		1x6	1x6	2x4	2x4		2x4	1x6	1X6	2x4	2x4	2x4	2x4
	Lower frame										2x4						2x4		2x4				2x4	2x4	2x4
	Struts	1x6						1x6			2x4			1x6	1x6		2x4		2x4	1x6	1x6		2x4	2x4	2x4
	Diagonal	1x6			1x6			1x6			2x4		1x6	1x6			2x4	1x6	2x4	1x6		1x6	2x4	1x6	2x4
28	Upper frame	1x6	1x6					1x6	2x4	2x4	2x4	2x4		1x6	1x6	2x4	2x4		2x4	1x6	2x4	2x4	2x4	2x4	2x4
	Lower frame	1x6						1x6			2x4			1x6			2x4		2x4	1x6			2x4	2x4	2x4
	Struts	1x6						1x6			2x4			1x6	1x6		2x4		2x4	1x6	1x6		2x4	2x4	2x4
	Diagonal	1x6			1x6			1x6			2x4		1x6	1x6			2x4	1x6	2x4	1x6			2x4	2x4	2x4
32	Upper frame	1x6	1x6		2x4			1x6	2x4	2x4	2x4	2x4	2x4	1x6	1x6	2x4	2x4		2x4	1x6	2x4	2x4	2x4	2x4	2x4
	Lower frame	1x6	1x6		2x4			1x6			2x4		2x4	1x6			2x4		2x4	1x6			2x4	2x4	2x4
	Struts	1x6			2x4			1x6			2x4		2x4	1x6	1x6		2x4		2x4	1x6	1x6	1x6	2x4	2x4	2x4
	Diagonal	1x6			2x4		1x6	1x6			2x4	1x6	2x4	1x6	1x6		2x4	1x6	2x4	1x6		1x6	2x4	2x4	2x6

*Crates 12 feet high in 6-foot widths and crates 10 feet high in 8-foot widths require 2x4 vertical joists supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

Table 6-37. Panel member selection table for 6,000 lb. net load

Note. All balnk spaces are 1x4s.

		4 foot width						6 foot width						8 foot width						10 foot width					
Length		Height (ft.)						Height (ft.)						Height (ft.)						Height (ft,.)					
(ft.)	Member	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
6	Lower frame																		2x4				2x4	2x4	2x4
	Struts																		2x4				2x4	2x4	2x4
	Diagonal				1x6						1x6						1x6		2x4				2x4		
	Upper frame							2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
8	Lower frame										2x4								2x4				2x4	2x4	2x4
	Struts										2x4								2x4				2x4	2x4	2x4
	Diagonal				1x6		1x6				2x4		1x6		1x6	2x4	1x6					1x6	2x4		2x4
	Upper frame				2x4			2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
10	Lower frame				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Struts				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Diagonal				2x4						2x4		1x6				2x4		1x6			1x6	2x4	2x4	2x4
	Upper frame	1x6			2x4			2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
12	Lower frame				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Struts				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Diagonal				2x4						2x4		1x6				2x4	1x6	1x6			1x6	2x4	1x6	2x4
	Upper frame	2x6			2x4			2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x6	2x4	2x4	2x4	2x4	2x4
16	Lower frame				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Struts				2x4						2x4						2x4		2x4		1x6		2x4	2x4	2x4
	Diagonal				2x4						2x4		1x6				2x4	1x6	1x6			1x6	2x4	1x6	2x4
	Upper frame	2x6	1x6		2x4			2x4	2x4	2x4	2x4	2x4		2x6	2x4	2x4	2x4		2x4	2x6	2x4	2x4	2x4	2x4	2x4
20	Lower frame				2 x4						2x4						2x4		2x4				2x4	2x4	2x4
	Struts				2x4						2x4	1x6	1x6	2x4	1x6	2x4	1x6	2x4			1x6		2x4	2x4	2x4
	Diagonal				2x4					1x6	2x4		1x6			1x6	2x4	1x6	2x4			1x6	2x4	1x6	2X4
	Upper frame	1x6	1x6	1x6	2x4			1x6	1x6	1x6	2x4	2x4	2x4	1x6	2x6	2x4	2x4	2x4	2x4	1x6	2x6	2x4	2x4	2x4	2x4
24	Lower frame	1x6			2x4			1x6			2x4		2x4	1x6			2x4	2X4	2x4	1x6			2x4	2x4	2x4
	Struts	1x6			2x4			1x6			2x4	1x6	2x4	1x6	1x6		2x4	2X4	2x4	1x6	1x6		2x4	2x4	2x4
	Diagonal	1x6			2x4		1x6	1x6		1x6	2x4	1x6	2x4	1x6		1x6	2x4	2x4	2x4	1x6		1x6	2x4	1x6	2x4
	Upper frame	1x6	2x4	1x6	2x4			1x6	2x4	2x4	2x4	2x4	2x4	2x6	2x6	2x4	2x4	2x4	2x4	2x6	2x6	2x4	2x4	2x4	2x4
28	Lower frame	1x6			2x4			1x6			2x4		2x4	1x6			2x4	2x4	2x4	1x6		2X4	2x4	2x4	2x4
	Struts	1x6			2x4			1x6			2x4		2x4	1x6	1x6		2x4	2x4	2x4	1x6	1x6	2X4	2x4	2x4	2x4
	Diagonal	1x6			2x4		1x6	1x6		1x6	2x4	1x6	2x4	1x6		1x6	2x4	2x4	2x4	1x6		2X4	2x4	2x4	2x6
	Upper frame	2x6	2x6	1x6	2x4		2x4	2x6	2x6	2x4	2x4	2x4	2x4	2x6	2x6	2x4	2x4	2x4	2x4	2x6	2x6	2x4	2x4	2x4	2x4
32	Lower frame	1x6			2x4		2x4	1x6			2x4		2x4	1x6		2x4	2x4	2x4	2x4	1x6		2X4	2x4	2x4	2x4
	Struts	1x6			2x4		2x4	1x6			2x4		2x4	1x6	1x6	2x4	2x4	2x4	2x4	1x6	1x6	1x6	2x4	2x4	2x4
	Diagonal	1x6		1x6	2x4	1x6	2x4	1x6		1x6	2x4	1x6	2x4	1x6		2x4	2x4	2x4	2x4	1x6	1x6	2X4	2x6	2x6	2x6

*Crates 12 feet high in 6-foot widths and crates 10 feet high in 8-foot widths require 2x4 vertical joists supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

Table 6-38. Panel member selection table for 8,000 lb. net load.*

Note. All balnk spaces are 1x4s.

		4 foot width						6 foot width						8 foot width						10 foot width					
Length		Height (ft.)						Height (ft.)						Height (ft.)						Height (ft,.)					
(ft.)	Member	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
	Upper frame				2x4			2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
6	Lower frame				2x4						2x4								2x4				2x4	2x4	2x4
	Struts				2x4						2x4								2x4				2x4	2x4	2x4
	Diagonal			1x6	2x4		1x6			1x6	2x4	1x6	1x6				1x6		2x4				2x4		
	Upper frame	1x6		2x4			2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
8	Lower frame				2x4		2x4				2x4								2x4				2x4	2x4	2x4
	Struts				2x4		2x4				2x4								2x4				2x4	2x4	2x4
	Diagonal			1x6	2x4		2x4				2x4		1x6		1x6	2x4	1x6					1x6	2x4		2x4
	Upper frame	1x6			2x4			2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
10	Lower frame				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Struts				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Diagonal				2x4		1x6				2x6		1x6				2x4		1x6			1x6	2x4	2x4	2x4
	Upper frame	2x6			2x4			2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
12	Lower frame				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Struts				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Diagonal			1x6	2x4	1x6	1x6				2x4		1x6				2x4	1x6	1x6			1x6	2x4	1x6	2x4
	Upper frame	2x6			2x4			2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4		2x4	2x6	2x4	2x4	2x4	2x4	2x4
16	Lower frame				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Struts				2x4						2x4						2x4		2x4		1x6		2x4	2x4	2x4
	Diagonal			1x6	2x4	1x6	1x6				2x4		1x6				2x4	1x6	1x6			1X6	2x4	1x6	2x4
	Upper frame	2x6	1x6		2x4			2x4	2x4	2x4	2x4	2x4		2x6	2x4	2x4	2x4		2x4	2x6	2x4	2x4	2x4	2x4	2x4
20	Lower frame				2x4						2x4						2x4		2x4				2x4	2x4	2x4
	Struts				2x4						2x4	1x6	1x6	2x4	1x6	2x4	1x6	2x4			1x6		2x4	2x4	2x4
	Diagonal			1x6	2x4	1x6	1x6			1x6	2x4		1x6			1x6	2x4	1x6	2x4			1x6	2x4	1x6	2x4
	Upper frame	2x6	2x6	1x6	2x4		2x4	1x6	1x6	1x6	2x4	2x4	2x4	1x6	2x6	2x4	2x4	2x4	2x4	1x6	2x6	2x4	2x4	2x4	2x4
24	Lower frame	1x6			2x4		2x4	1x6			2x4		2x4	1x6			2x4	2x4	2x4	1x6			2x4	2x4	2x4
	Struts	1x6			2x4	1x6	2x4	1x6			2x4	1x6	2x4	1x6	1x6		2x4	2x4	2x4	1x6	1x6		2x4	2x4	2x4
	Diagonal	1x6		1x6	2x4	1x6	2x4	1x6		1x6	2x4	1x6	2x4	1x6		1x6	2x4	2x4	2x4	1x6		1x6	2x4	1x6	2x4
	Upper frame	2x6	2x6	2x4	2x4	2x4	2x4	1x6	2x4	2x4	2x4	2x4	2x4	2x6	2x6	2x4	2x4	2x4	2x4	2x6	2x6	2x4	2x4	2x4	2x4
28	Lower frame	1x6		2x4	2x4	2x4	2x4	1x6			2x4		2x4	1x6			2x4	2x4	2x4	1x6		2x4	2x4	2x4	2x4
	Struts	1x6		2x4	2x4	2x4	2x4	1x6			2x4		2x4	1x6	1x6		2x4	2x4	2x4	1x6	1x6	2x4	2x4	2x4	2x4
	Diagonal	1x6		2x4	2x4	2x4	2x4	1x6		1x6	2x4	1x6	2x4	1x6		1x6	2x4	2x4	2x4	1x6		2x4	2x4	2x4	2x6
	Upper frame	2x8	2x8	1x6	2x4		2x4	2x6	2x6	2x4	2x4	2x4	2x4	2x6	2x6	2x4	2x4	2x4	2x4	2x6	2x6	2x4	2x4	2x4	2x4
32	Lower frame	1x8			2x4		2x4	1x6			2x4		2x4	1x6		2x4	2x4	2x4	2x4	1x6		2x4	2x4	2x4	2x4
	Struts	1x8			2x4		2x4	1x6			2x4		2x4	1x6	1x6	2x4	2x4	2x4	2x4	1x6	1x6	1x6	2x4	2x4	2x4
	Diagonal	2x8		1x6	2x4	1x6	2x4	1x6		1x6	2x4	1x6	2x4	1x6		2x4	2x4	2x4	2x4	1x6	1x6	2x4	2x6	2x6	2x6

*Crates 12 feet high in 6-foot widths and crates 10 feet high in 8-foot widths require 2x4 vertical joists supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

Table 6-39. Panel member selection table for 10,000 lb. net load.*

Note. All balnk spaces are 1x4s.

		4 foot width						6 foot width						8 foot width						10 foot width					
Length		Height (ft.)						Height (ft.)						Height (ft.)						Height (ft,.)					
(ft.)	Member	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
	Upper frame				2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
6	Lower frame				2x4		2x4				2x4		2x4			2x4	2x4		2x4			2x4	2x4	2x4	2x4
	Struts				2x4	1x6	2x4			1x6	2x4	1x6	2x4		1x6	2x4	2x4	1x6	2x4		1x6	2x4	2x4	2x4	2x4
	Diagonal			1x6	2x4	1x6	2x4			1x6	2x4	1x6	2x4			2x4	2x4	1x6	2x4		1x6	2x4	2x4	2x4	2x4
	Upper frame	1x6		2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
8	Lower frame			2x4	2x4		2x4			2x4	2x4		2x4			2x4	2x4		2x4			2x4	2x4	2x4	2x4
	Struts			2x4	2x4	1x6	2x4			2x4	2x4	1x6	2x4		1x6	2x4	2x4	1x6	2x4		1x6	2x4	2x4	2x4	2x4
	Diagonal		1x6	2x4	2x4	1x6	2x4	1x6	1x6	2x4	2x4	1x6	2x4	1x6	1x6	2x4	2x4	1x6	2x4	1x6	1x6	2x4	2x4	1x6	2x6
	Upper frame	1x6			2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4		2x4	2x4	2x4	2x4	2x4	2x4	2x4
10	Lower frame				2x4		2x4				2x4		2x4				2x4		2x4			2x4	2x4	2x4	2x4
	Struts			1x6	2x4	1x6	2x4			1x6	2x4	1x6	2x4			1x6	2x4	1x6	2x4			2x4	2x4	2x4	2x4
	Diagonal		1x6	1x6	2x4	1x6	2x4	1x6	1x6	1x6	2x6	1x6	2x4	1x6	1x6	1x6	2x6	1x6	2x4	1x6	1x6	2x4	2x6	2x4	2x4
	Upper frame	2x6			2x4		2x4	2x6	2x4	2x4	2x4	2x4	2x4	2x6	2x4	2x4	2x4	2x4	2x4	2x6	2x4	2x4	2x4	2x4	2x4
12	Lower frame				2x4		2x4			2x4	2x4	2x4	2x4			2x4	2x4	2x4	2x4			2x4	2x4	2x4	2x4
	Struts			1x6	2x4	1x6	2x4			2x4	2x4	2x4	2x4			2x4	2x4	2x4	2x4			2x4	2x4	2x4	2x4
	Diagonal		1x6	1x6	2x4	1x6	2x4	1x6	1x6	2x4	2x4	2x4	2x4	1x6	1x6	2x4	2x4	2x4	2x4	1x6	1x6	2x4	2x4	2x4	2x4
	Upper frame	2x8	1x6		2x4		2x4	2x8	2x4	2x4	2x4	2x4	2x4	2x8	2x4	2x4	2x4	2x4	2x4	2x8	2x4	2x4	2x4	2x4	2x4
16	Lower frame				2x4		2x4			2x4	2x4	2x4	2x4			2x4	2x4	2x4	2x4			2x4	2x4	2x4	2x4
	Struts				2x4	1x6	2x4			2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4		1x6	2x4	2x4	2x4	2x4
	Diagonal	1x6	1x6	1x6	2x4	1x6	2x4	1x6	1x6	2x4	2x4	2x4	2x4	1x6	1x6	2x4	2x6	2x4	2x4	1x6	1x6	2x4	2x6	2x6	2x4
	Upper frame	2x8	2x4	2x4	2x4		2x4	2x8	2x6	2x4	2x4	2x4	2x4	2x8	2x6	2x4	2x4	2x4	2x4	2x8	2x6	2x4	2x4	2x4	2x4
20	Lower frame	1x6		2x4	2x4		2x4	1x6		2x4	2x4	2x4	2x4	1x6		2x4	2x4	2x4	2x4	1x6	2x4	2x4	2x4	2x4	2x4
	Struts			2x4	2x4	1x6	2x4			2x4	2x4	2x4	2x4			2x4	1x6	2x4	2x6		2x4	2x4	2x4	2x4	2x6
	Diagonal	1x6		2x4	2x4	1x6	2x4	1x6	1x6	2x4	2x4	2x4	2x4	1x6	1x6	2x4	2x6	2x4	2x6	1x6	2x4	2x4	2x6	2x6	2x6
	Upper frame	2x8	2x6	2x4	2x4	2x4	2x4	2x8	2x6	2x6	2x4	2x4	2x4	2x8	2x6	2x6	2x4	2x4	2x4	2x8	2x8	2x6	2x4	2x4	2x4
24	Lower frame	1x8		2x4	2x4	2x4	2x4	1x8		2x4	2x4	2x4	2x4	1x8		2x4	2x4	2x4	2x4	1x8	2x4	2x4	2x4	2x4	2x4
	Struts	1x6		2x4	2x4	2x4	2x4	1x8	1x6	2x4	2x4	2x4	2x4	1x8	1x6	2x4	2x4	2x6	2x6	1x8	2x4	2x4	2x4	2x4	2x6
	Diagonal	1x6	1x6	2x4	2x4	2x4	2x4	1x8	1x6	2x4	2x6	2x6	2x6	1x8	1x6	2x4	2x6	2x6	2x6	1x8	2x4	2x4	2x6	2x6	2x6
	Upper frame	2x8	2x6	2x4	2x4	2x4	2x4	2x8	2x6	2x6	2x4	2x4	2x4	2x8	2x8	2x6	2x6	2x4	2x4	2x8	2x8	2x6	2x6	2x4	2x4
28	Lower frame	1x8		2x4	2x4	2x4	2x4	1x8		2x4	2x4	2x4	2x4	1x8	2x4	2x4	2x4	2x4	2x4	1x8	2x4	2x4	2x4	2x4	2x4
	Struts	1x8		2x4	2x4	2x4	2x4	1x8		2x4	2x4	2x4	2x4	1x8	2x4	2x4	2x4	2x4	2x4	1x8	2x4	2x4	2x4	2x4	2x4
	Diagonal	1x8	1x6	2x4	2x4	2x4	2x4	1x8	1x6	2x4	2x6	2x6	2x6	1x8	2x4	2x4	2x6	2x6	2x6	1x8	2x4	2x4	2x6	2x6	2x6
	Upper frame	2x8	2x8	2x6	2x6	2x4	2x4	2x8	2x8	2x6	2x6	2x4	2x4	2x10	2x10	2x6	2x6	2x4	2x4	1x10	2x10	2x6	2x6	2x4	2x4
32	Lower frame	1x8		2x4	2x4	2x4	2x4	1x8		2x4	2x4	2x4	2x4	2x6	2x4	2x4	2x4	2x4	2x4	2x6	2x4	2x4	2x4	2x4	2x4
	Struts	1x8	1x6	2x4	2x4	2x4	2x4	1x8	1x6	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4	2x4
	Diagonal	2x8	1x6	2x4	2x6	2x4	2x6	2x8	1x6	2x4	2x6	2x6	2x6	2x8	2x4	2x4	2x6	2x6	2x6	2x8	2x4	2x6	2x6	2x6	2x6

*Crates 12 feet high in 6-foot widths and crates 10 feet high in 6-foot widths require 2x4 vertical joists supports when struts are 1 inch thick; all other sizes use horizontal joist supports.

Table 6-40. Panel member selectiontable for 15,000 lb. net load.*

Note. All balnk spaces are 2x4s.

		4 foot width					6 foot width					8 foot widht					10 foot width				
Length		Height (ft.)					Height (ft.)					Height (ft.)					Height (ft.)				
(ft.)	Member	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12
	Upper frame																				
6	Lower frame																				
	Struts														2x6	2x6			2x6	2x6	2x6
	Diagonal			2x6	2x6	2x6			2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6
	Upper frame																				
8	Lower frame																				
	Struts									2x6	2x6			2x6	2x6	2x6		2x6	2x6	2x6	2x6
	Diagonal		2x6	2x6		2x6		2x6	2x6		2x6		2x6	2x6		2x6		2x6	2x6	2x6	2x6
	Upper frame																				
10	Lower frame																				
	Struts								2x6	2x6	2x6			2x6	2x6	2x6		2x6	2x6	2x6	2x6
	Diagonal		2x6	2x6	2x6			2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6
	Upper frame																				
12	Lower frame																				
	Struts					2x6			2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6
	Diagonal			2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
	Upper frame											2x6					2x6				
16	Lower frame																				
	Struts				2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6
	Diagonal			2x6	2x6	2x6			2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
	Upper frame	2x6					2x6					2x6					2x6				
20	Lower frame																				
	Struts				2x6	2x6				2x6	2x6				2x6	2x6				2x6	2x6
	Diagonal		2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
	Upper frame	2x8	2x8				2x8	2x6				2x8	2x6	2x6	2x6		2x8	2x6	2x6	2x6	2x6
24	Lower frame	2x6	2x6				2x6					2x6					2x6				
	Struts				2x6	2x6				2x6	2x6		2x6		2x6	2x6		2x6		2x6	2x6
	Diagonal		2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8
	Upper frame	2x10	2x6	2x8			2x10	2x8	2x8			2x10	2x8	2x6	2x6	2x8	2x10	2x8	2x6	2x6	2x6
28	Lower frame	2x6					2x6					2x6					2x6				
	Struts								2x6					2x6					2x6		
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8
	Upper frame	2x10	2x6	2x6			2x10	2x8	2x8			2x10	2x8	2x8	2x6	2x8	2x10	2x8	2x6	2x6	2x6
32	Lower frame	2x8					2x8					2x8					2x8				
	Struts	2x6							2x8					2x8			2x8		2x8		
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x8	2x8	2x8

*The above sizes are for uniform loads, but also apply to concentrated loads.

Table 6-41. Panel member sleection table for 20,000 lb. net load.*

Note. All blank spaces are 2x4s.

		4 foot width					6 foot width					8 foot widht					10 foot width				
Length		Height (ft.)					Height (ft.)					Height (ft.)					Height (ft.)				
(ft.)	Member	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12
	Upper frame																				
6	Lower frame																				
	Struts	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
	Upper frame	2x6	2x6				2x6	2x6				2x6	2x6				2x6	2x6			
8	Lower frame																				
	Struts	2X6	2x6	2x6	2x6	2x6	2X6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x8	2x6	2x6	2x8	2x6	2x8	2x6	2x8	2x8	2x6	2x8
	Upper frame	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6		
10	Lower frame																				
	Struts		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
	Upper frame	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6		
12	Lower frame																				
	Struts		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6
	Upper frame	2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6	
16	Lower frame																				
	Struts	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x8
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x8	2x8	2x6	2x6	2x6	2x8	2x8	2x6
	Upper frame	2x8	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6
20	Lower frame																				
	Struts				2x6	2x6				2x6	2x6				2x6	2x8				2x8	2x8
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x8	2x6	2x6	2x8	2x8	2x8
	Upper frame	2x10	2x8	2x6	2x6	2x6	2x10	2x8	2x6	2x6	2x6	2x10	2x8	2x6	2x6	2x6	2x10	2x8	2x6	2x6	2x6
24	Lower frame						2x6					2x6					2x6				
	Struts	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x6	2x6	2x6		2x6	2x8	2x8	2x8		2x8	2x8
	Diagonal	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x8	2x8	2x6	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8
	Upper frame	2x10	2x8	2x8	2x6	2x6	2x10	2x8	2x8	2x6	2x6	2x10	2x8	2x8	2x6	2x6	2x10	2x8	2x8	2x6	2x6
28	Lower frame						2x8					2x8					2x8				
	Struts			2x8					2x8					2x8					2x8		
	Diagonal	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8
	Upper frame	2x10	2x8	2x8	2x6	2x6	2x10	2x8	2x8	2x6	2x6	2x10	2x8	2x8	2x6	2x6	2x10	2x10	2x10	2x6	2x6
32	Lower frame																				
	Struts			2x8					2x8					2x8					2x8		
	Diagonal	2x6	2x6	2x8	2x6	2x8	2x6	2x6	2x8	2x8	2x8	2x6	2x8	2x8	2x8	2X8	2x6	2x8	2x8	2x8	

*The above sizes are for uniform loads, but also apply to concentrated loads.

Table 6-42. Panel member sleection table for 25,000 lb. net load.*

Note. All blank spaces are 2x4s

		4 foot width					6 foot width					8 foot widht					10 foot width				
Length		Height (ft.)					Height (ft.)					Height (ft.)					Height (ft.)				
(ft.)	Member	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12
	Upper frame	2x6	2x6				2x6	2x6				2x6	2x6				2x6	2x6			
6	Lower frame																				
	Struts	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8		2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8
	Diagonal	2x6	2x8	2x8	2x8	2x8	2x6	2x8	2x8	2x8	2x8	2x6	2x8	2x8	2x8	2x8	2x6	2x8	2x8	2x8	2x8
	Upper frame	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6		
8	Lower frame																				
	Struts	2x6	2x6	2x6	2x6	2x6	2x6	2X6	2x6	2x8	2x8	2x6	2x8	2x8	2x8	2x8	2x6	2x8	2x8	2x8	2x8
	Diagonal	2x6	2x8	2x8	2x6	2x8	2x6	2x8	2x8	2x6	2x8	2x6	2x8	2x8	2x6	2x8	2x6	2x8	2x8	2x6	2x10
	Upper frame	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6		
10	Lower frame																				
	Struts		2x6	2x6	2x8	2x8		2x6	2x8	2x8	2x8		2x8	2x8	2x8	2x8		2x8	2x8	2x8	2x8
	Diagonal	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8
	Upper frame	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6		
12	Lower frame																				
	Struts		2x8	2x6	2x8	2x8		2x8	2x8	2x8	2x8		2x8	2x8	2x8	2x8		2x8	2x8	2x8	2x8
	Diagonal	2x6	2x8	2x8	2x8	2x8	2x6	2x8	2x8	2x8	2x8	2x6	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8
	Upper frame	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6
16	Lower frame																				
	Struts	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8	2x6		2x8	2x8	2x8	2x6		2x8	2x8	2x8
	Diagonal	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8	2x6	2x6	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8
	Upper frame	2x10	2x6	2x6	2x6	2x6	2x10	2x6	2x6	2x6	2x6	2x10	2x6	2x6	2x6	2x6	2x10	2x6	2x6	2x6	2x6
20	Lower frame																				
	Struts				2x8	2x8				2x8	2x8				2x8	2x8				2x8	2x8
	Diagonal	2x6	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8
	Upper frame	2x8	2x10	2x6	2x6	2x6	2x10	2x10	2x8	2x8	2x6	2x10	2x10	2x8	2x8	2x6	2x10	2x10	2x8	2x8	2x6
24	Lower frame																				
	Struts		2x8		2x8	2x8		2x8		2x8	2x8		2x8		2x8	2x8		2x8		2x8	2x8
	Diagonal	2x6	2x8	2x8	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x10	2x8	2x8	2x8	2x10	2x10	2x10
	Upper frame	2x10	2x10	2x10	2x6	2x6	2x10	2x10	2x10	2x8	2x6	2x10	2x10	2x10	2x8	2x6	2x10	2x10	2x10	2x8	2x6
28	Lower frame											2x8					2x8				
	Struts			2x8				2x8						2x10		2x8			2x8	2x6	2x6
	Diagonal	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x10
	Upper frame	2x12	2x10	2x10	2x6	2x6	2x12	2x10	2x10	2x8	2x6	2x12	2x10	2x10	2x8	2x6	2x12	2x10	2x10	2x8	2x6
32	Lower frame	2x6					2x6					2x6					2x6				
	Struts			2x8						2x8				2x8					2x8		
	Diagonal	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x10	2x10	2x8	2x8	2x10	2x10	2x10

*The above sizes are for uniform loads, but also apply to concentrated loads.

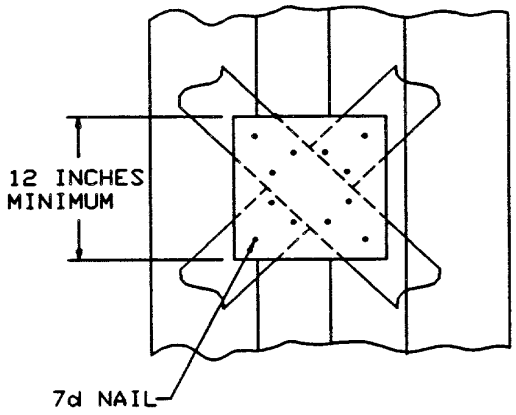
Table 6-43. Panel member selection table for 30,000 lb. net load.*

Note. All blank spaces are 2x4s

		4 foot width					6 foot width					8 foot widht					10 foot width				
Length		Height (ft.)					Height (ft.)					Height (ft.)					Height (ft.)				
(ft.)	Member	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12	4	6	8	10	12
	Upper frame	2x6	2X6				2x6	2x6	2X8			2x6	2x6	2X6			2x6	2x6	2X6		
6	Lower frame																				
	Struts	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8
	Diagonal	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x10
	Upper frame	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6		
8	Lower frame																				
	Struts	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8
	Diagonal	2x8	2x10	2x10	2x8	2x10	2x8	2x10	2x10	2x8	2x10	2x8	2x10	2x10	2x8	2x10	2x8	2x10	2x10	2x8	2x10
	Upper frame	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6		
10	Lower frame																				
	Struts		2x8	2x10	2x8	2x8		2x8	2x10	2x8	2x8		2x8	2x10	2x8	2x8		2x8	2x10	2x8	2x8
	Diagonal	2x6	2x6	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x8	2x8
	Upper frame	2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6			2x6	2x6	2x6		
12	Lower frame																				
	Struts		2x8	2x8	2x8	2x8		2x8	2x8	2x8	2x8		2x8	2x8	2x8	2x8		2x8	2x8	2x8	2x8
	Diagonal	2x8	2x8	2x8	2x10	2x10	2x8	2x8	2x8	2x10	2x10	2x8	2x8	2x10	2x10	2x10	2x8	2x8	2x10	2x10	2x10
	Upper frame	2x8	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6	2x8	2x6	2x6	2x6	2x6
16	Lower frame																				
	Struts	2x10		2x10	2x8	2x8	2x10		2x10	2x8	2x8	2x10		2x10	2x8	2x8	2x10		2x10	2x10	2x10
	Diagonal	2x8	2x8	2x10	2x8	2x8	2x8	2x8	2x10	2x10	2x8	2x8	2x8	2x10	2x10	2x8	2x8	2x8	2x10	2x10	2x10
	Upper frame	2x10	2x8	2x6	2x6	2x6	2x10	2x8	2x6	2x6	2x6	2x10	2x8	2x6	2x6	2x6	2x10	2x10	2x6	2x6	2x6
20	Lower frame											2X8					2X8				
	Struts				2x8	2x8				2x8	2x8			2x6	2x8	2x10			2x6	2x10	2x10
	Diagonal	2x8	2x8	2x10	2x8	2x8	2x8	2x10	2x10	2x8	2x10	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10
	Upper frame	2x10	2x10	2x8	2x8	2x6	2x10	2x10	2x8	2x8	2x6						2x10	2x10	2x8	2x8	2x8
24	Lower frame							2x8				2x10	2x10	2x8	2x8	2x8		2x8			
	Struts		2x8	2x8	2x8	2x8		2x8	2x8	2x8	2x10		2x8	2x6	2x10			2x8	2x6	2x10	2x10
	Diagonal	2x8	2x8	2x10	2x10	2x10	2x8	2x8	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10
	Upper frame	2x12	2x10	2x10	2x8	2x6	2x12	2x10	2x10	2x8	2x6	2x12	2x10	2x10	2x8	2x8	2x12	2x12	2x10	2x8	2x8
28	Lower frame	2x6					2x6	2x8				2x6	2x8				2x6	2x8			
	Struts			2x8		2x6			2x8	2x6	2x6		2x6	2x8	2x6	2x6		2x6	2x8	2x6	2x6
	Diagonal	2x8	2x8	2x10	2x10	2x10	2x8	2x8	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10
	Upper frame	2x12	2x12	2x10	2x8	2x6	2x12	2x12	2x10	2x8	2x8	2x12	2x12	2x10	2x8	2x8	2x12	2x12	2x10	2x8	2x8
32	Lower frame	2x6	2x8	2x8			2x8	2x8	2x8			2x8	2x8	2x8			2x8	2x8	2x8		
	Struts			2x8	2x6	2x6			2x8	2x6	2x6		2x6	2x8	2x6	2x6		2x6	2x8	2x6	2x6
	Diagonal	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x10	2x10	2x10	2x8	2x10	2x12	2x10	2x12

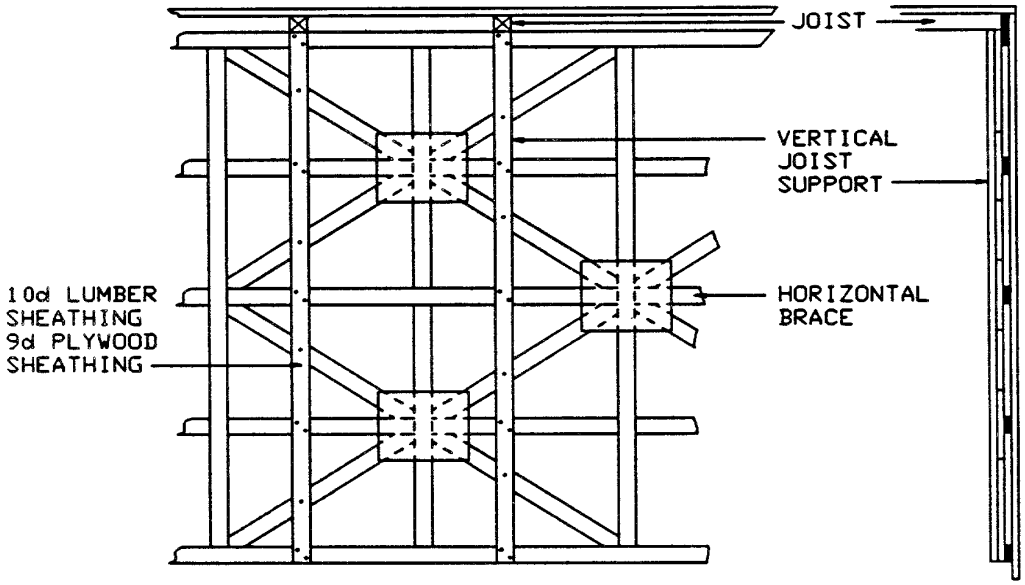
*The above sizes are for uniform loads, but also apply to concentrated loads.

MIL-C-104C



PLYWOOD GUSSET

1. USE 1/4 INCH PLYWOOD SHORTEST DIMENSION 12 INCHES MINIMUM.
2. USE 3 NAILS (MIN.) PER MEMBER INTERSECTION - CLINCH ON SHEATHING SIDE.
3. CENTER CORNERS ON CENTERLINE OF DIAGONALS.
4. FOR CRATES WITH 1 INCH MEMBERS AND HEIGHTS OVER 36 INCHES.



VERTICAL JOIST SUPPORTS

USE FOR 12 FOOT CRATE HEIGHT IN 6 FOOT WIDTH AND FOR 10 FOOT HEIGHT IN 8 FOOT WIDTH WHEN STRUTS ARE SHOWN AS 1 INCH THICK IN MEMBER SELECTION TABLES IV TO IX

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Figure 6-66. Joist supports and gussets (MIL-C-104).

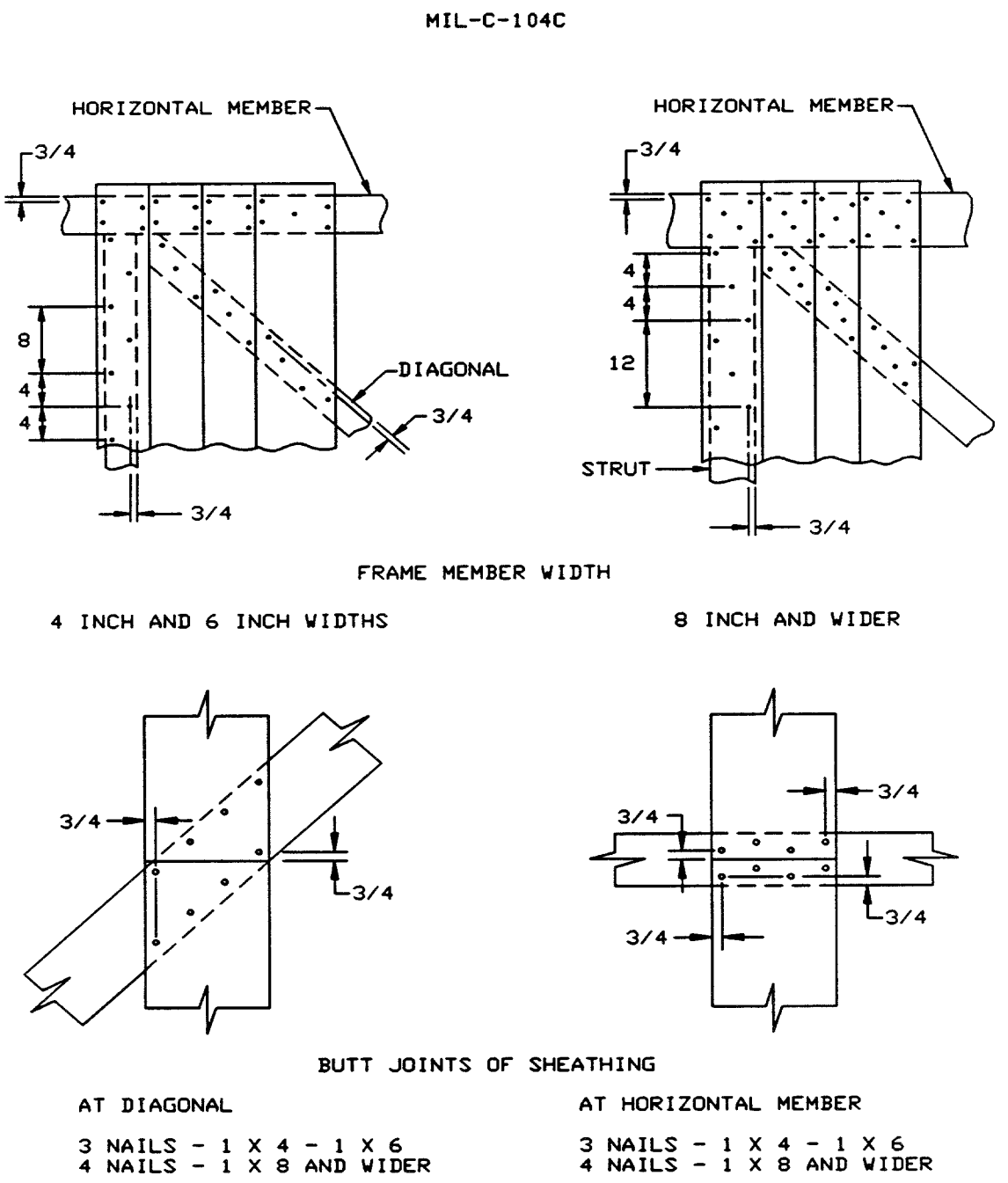


Figure 6-67. Fabrication nailing of lumber sheathing (MIL-C-104).

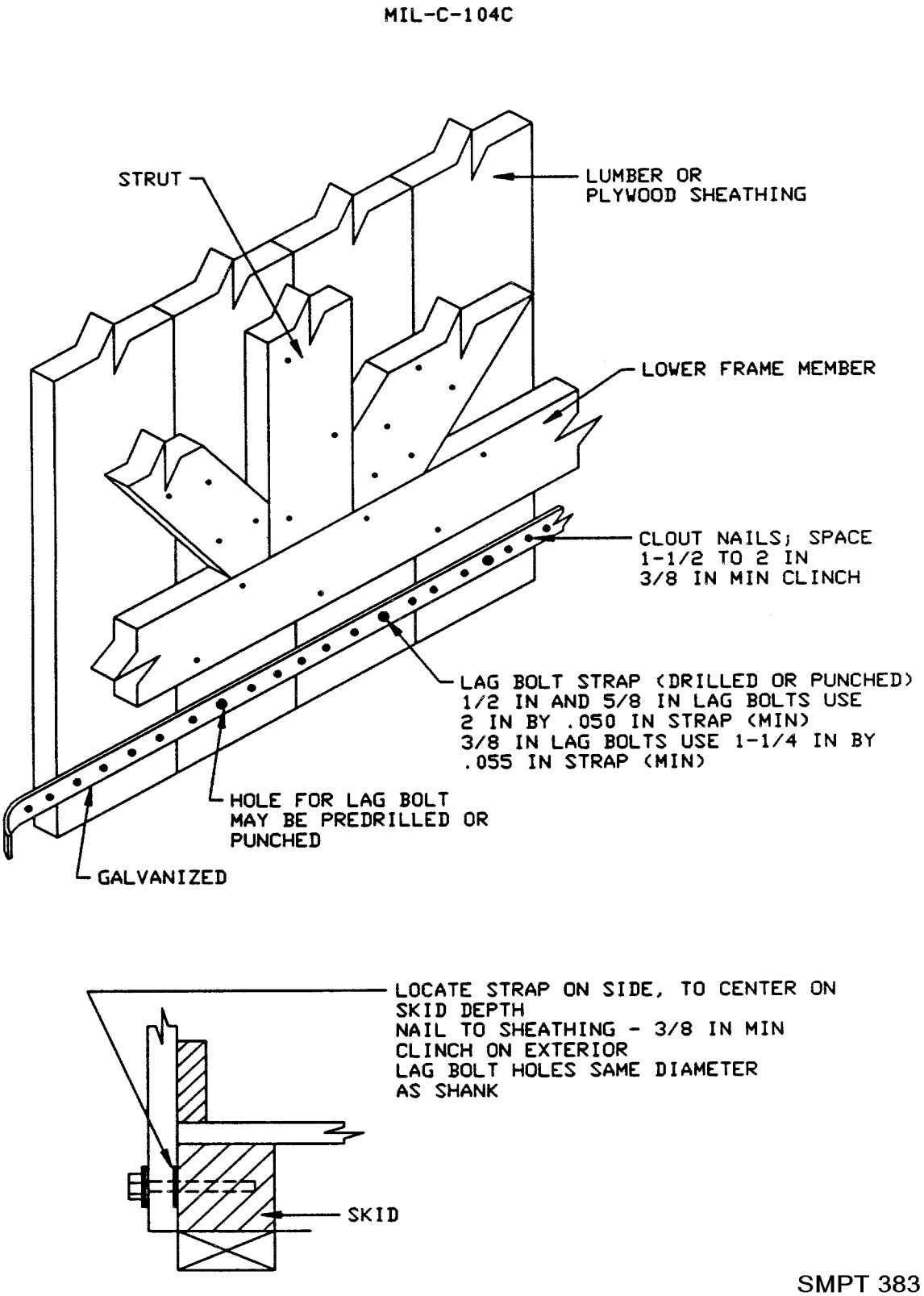


Figure 6-68. Lag screw reinforcing strap for bolted crates (MIL-C-104).

Table 6-44. Lag bolts required to assemble sides to base of bolted crates using lag bolt reinforcing strap (skids to be Group II, III, or IV woods).*

Weight of crate and contents (lb.)	Size of lag bolt		
	3/8 x 3-inch (3x3 or 3x4 inch skids)	1/2 x 4-inch (4 x 4 inch skids)	5/8 x 4-inch (4 x 6 inch skids)
2,000	6	6	6
3,000	10	6	6
4,000	14	8	6
6,000	20	12	8
8,000	...	16	10
10,000	...	18	12
12,000	...	22	14
14,000	...	26	16
16,000	...	30	18
18,000	...	32	22
20,000	...	36	24
24,000	...	...	28
28,000	...	...	32
32,000	...	...	36
36,000	...	...	42
40,000	...	...	46

* Use one-half the number on each side:

Maximum spacing - 3/8 x 3 - 16 inches on center
1/2 x 4 - 20 inches on center
5/8 x 4 - 20 inches on center

Minimum number - 3 per side, 2 per end

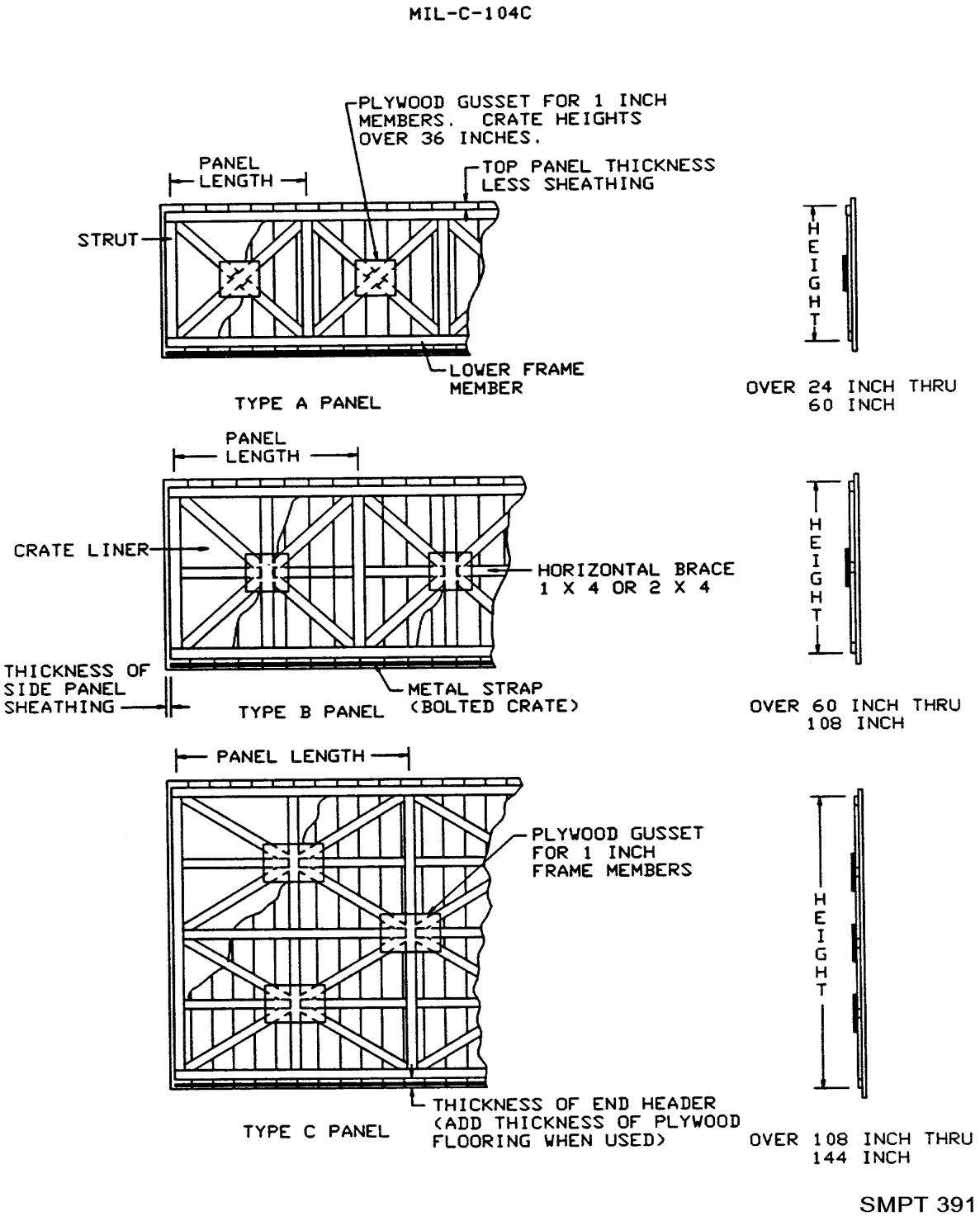


Figure 6-69. End panels over 30 inches wide lumber sheathed crates (MIL-C-104).

MIL-C-104C

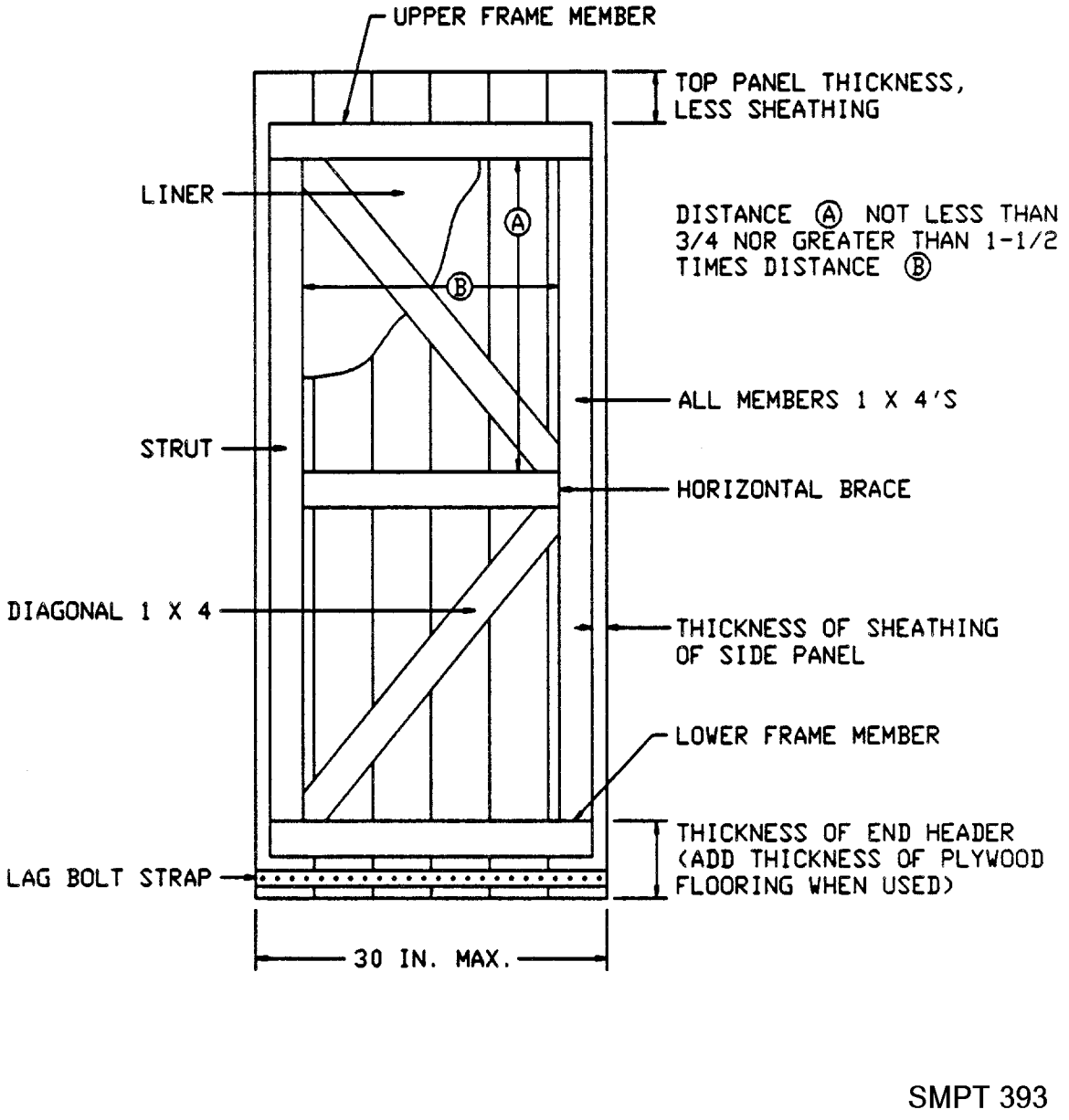


Figure 6-70. Narrow end panels (lumber sheathed crates) (MIL-C-104).

MIL-C-104C

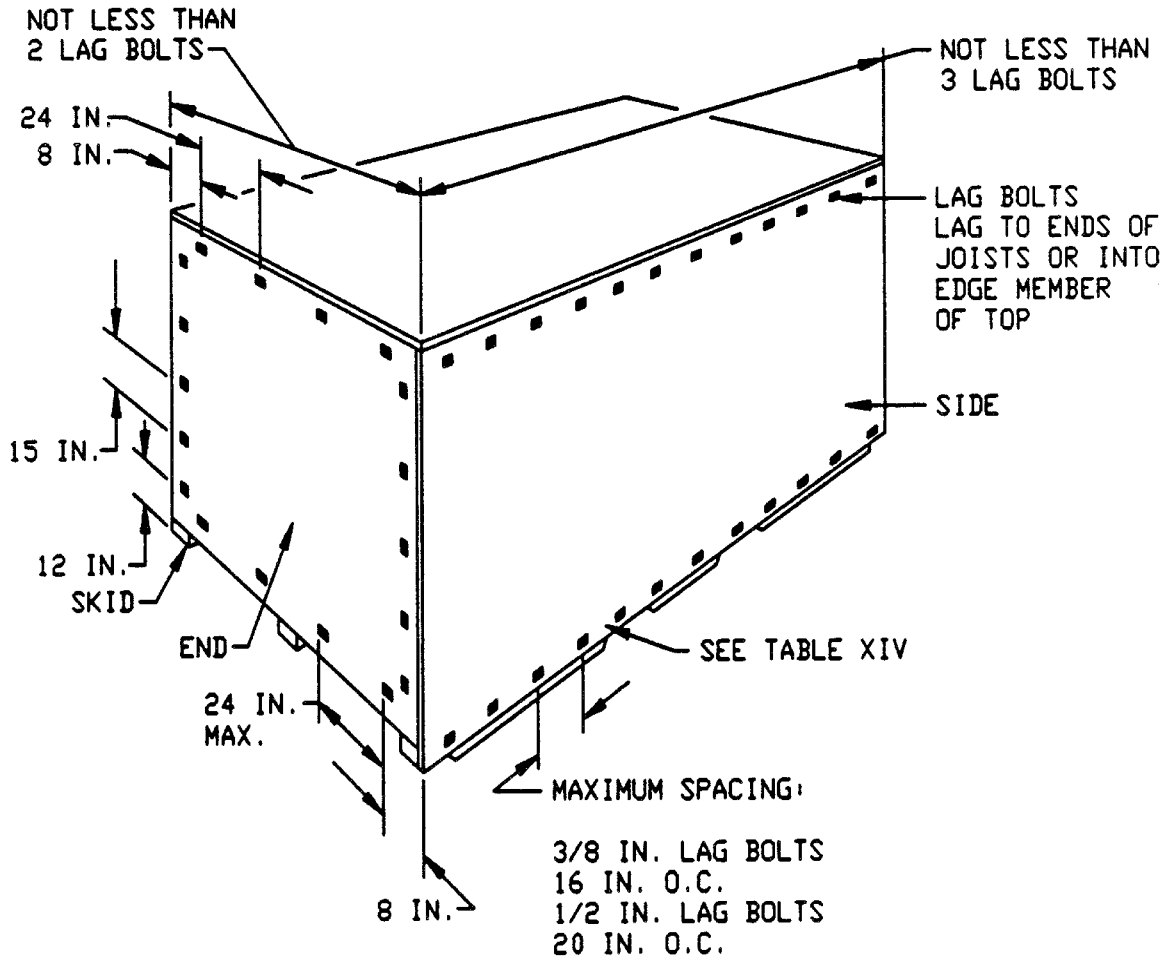
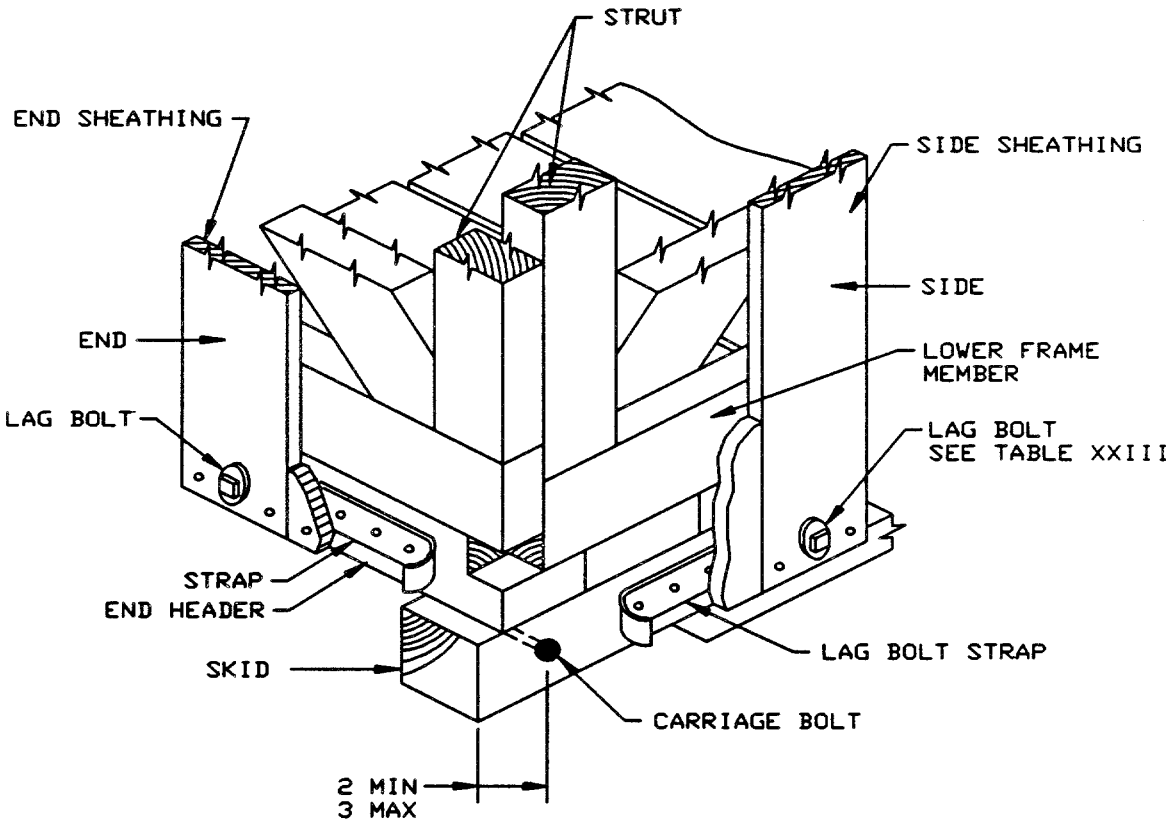


Figure 6-71. Assembly of bolted crate (lumber or pylwood sheathed) (MIL-C-104).

MIL-C-104C



VIEW OF LOWER CORNER

Note:

1. Dimensions are in inches.

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Figure 6-72. Assembly of bolted crate (MIL-C-104).

MIL-C-104C

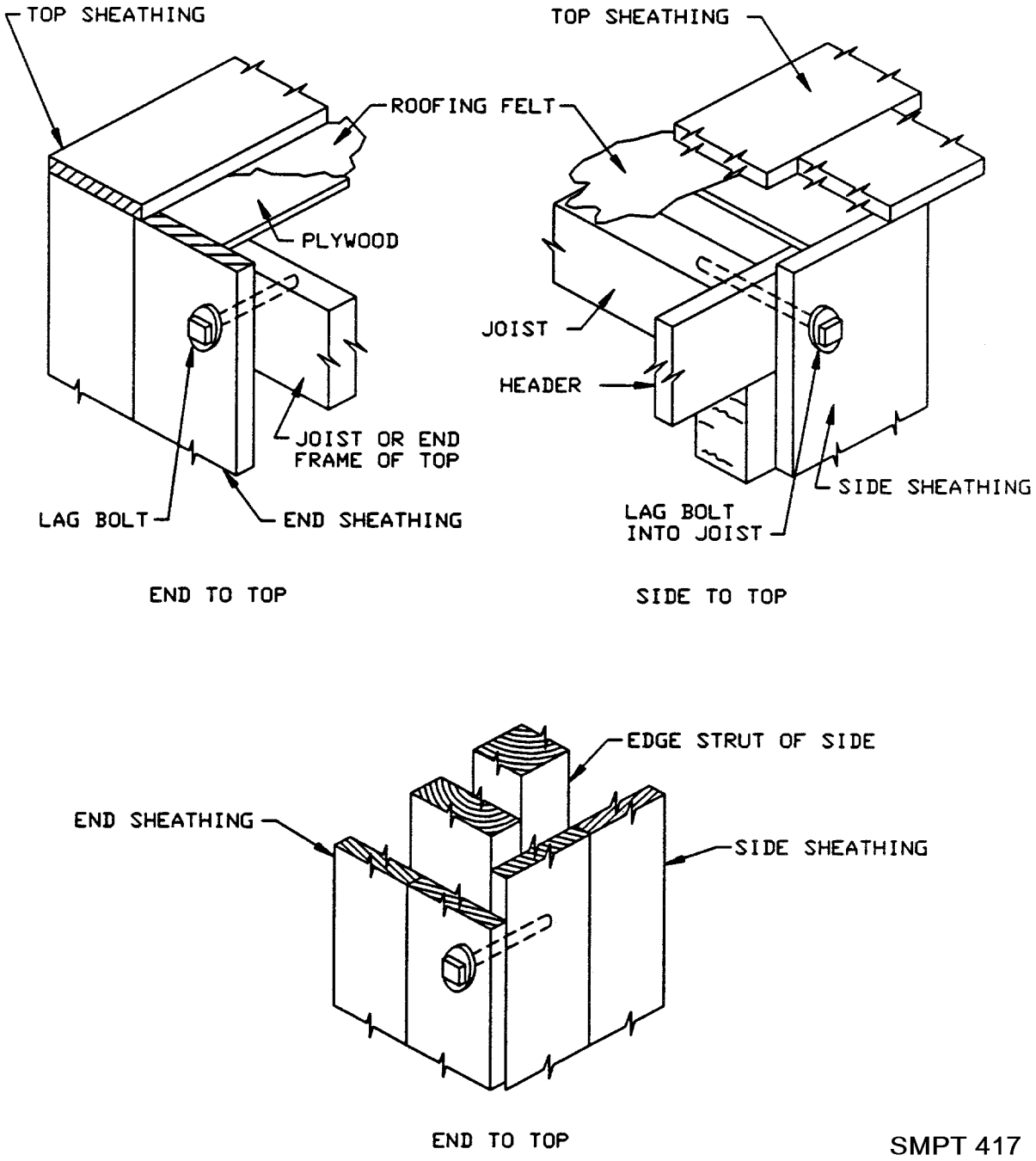

Figure 6-73. Assembly of bolted crate (MIL-C-104).

NAILED CRATE

General

Type I crates shall be assembled with nails and metal straps. General rules for crate assembly shall be as shown in table 6-45 and figures 6-74 and 6-75.

Fastening Sides and Ends to Base

Sides and ends shall be nailed to the skids and headers with cement-coated nails (figure 6-74). Two rows of nails shall be used for 2 by 4 inch, 3 by 3 inch, 3 by 4 inch and 4 by 4 inch skids or headers and for style b bases. The number of nails required for the perimeter of the crate shall be as shown in table 6-46, and based on the gross load. Nail spacing shall be no greater than 6 inches in each row, and not less than two nails shall be used in each sheathing board.

Fastening Ends to Sides and Sides to Ends

The end panels shall be nailed to the side panels with twentypenny cement-coated nails spaced 12 inches apart as shown in table 6-45 and figure 6-74. The nails shall pass through the sheathing and the edge struts of the ends into the edge of the corner struts of the sides. Predrilling shall be used for these nails to prevent splitting and the bit for drilling shall be approximately 75 percent of the diameter of the nail shank. The edge sheathing boards of the side panels shall be nailed to the edge struts of the ends with eightpenny cement-coated nails spaced 6 to 8 inches apart (figure 6-74).

Fastening Top to Sides and Ends

Tops shall be fastened to sides and ends with corner reinforcing straps and tensioned straps with anchor plates as shown in figure 6-75. Corner straps shall be of such length as to allow nailing into framing of sides and ends.

Strapping

Strapping shall be used as shown in figure 6-75 on all bolted crates with net loads over 3,000 lb and for all nailed crates. Tensioned metal strapping and corner straps shall conform to ASTM D 3953, Type 1 or 3, Zinc-Coated finish, Grade 2, not less than 3/4 inch wide by 0.028 inch thick. Corner strapping shall be prepunched or drilled. In addition, on crates with style b bases, corner reinforcing straps shall be applied at the bottom corners as shown in figure 6-76. Nails shall be 1-1/4 to 1-1/2 inch galvanized roofing nails. A minimum of three nails shall be used for each strap leg and strapping shall be located so that nailing is in a frame member.

CLASS 2 CRATES

Class 2 crates shall be Type I or II as specified and shall have the same use limitations as described for lumber-sheathed.

Bases

The construction of bases shall conform to bases of Class 1 crates.

Tops

The construction of tops for Class 2 crates is identical to that described for Class 1 tops.

Sides (see figures 6-77 thru 6-79)

Number and Type of Panels

Types of panels for various heights and corresponding illustrative figure number shall be as shown in table 6-47.

Type B panels include a horizontal brace and Type C panels have two horizontal braces. These shall be located so as to equally divide the space between upper and lower frame members. For all types of side panels, struts shall be spaced 24 inches on centers except at one or both ends so that 48 inch-wide plywood can be utilized with a minimum of waste. Sides shall be constructed as shown in figures 6-80 to 6-81. In crates with Style b bases, the sheathing of sides and ends shall reach below the horizontal frame member a distance equal to the depths of the sills.

Table 6-45. Assembly Nailing of Nailed Crate (MIL-C-104)[1]

Fasten		Nail size an spacing		Notes
Part	To part	Lumber sheathing	Plywood sheathing	
Sheathing of side and end	Skid and end header (skid base)	Eightpenny minimum size 3-inch maximum spacing	Sevenpenny minimum size 3-inch maximum spacing.	See table 6-40 for number of nails required
	End and side sills (sill base)	Two rows up to 4 x 4 skids Three rows for 4 x 6 skid (on edge) Three rows for all sill bases	Two rows up to 4 x 4 skids Three rows for 4 x 6 skid (on edge) Three rows for all sill bases	Predrill holes for twenty penny nails, 75 percent of shank diameter
Corner strut of end	Corner strut of side	Twentypenny-predrill 12-inch spacing	Twelvepenny 12 inch spacing	
Sheathing of side	Corner strut of end	Eightpenny minimum size 6- to 8-inch spacing	Sevenpenny minimum size 6- to 8-inch spacing	

[1]For fastening top to sides and ends use strapping.

Table 6-46. Number of nails per each 1,000 pound gross load (nailing sheathing to base around perimeter of nailed crate).*

Type of nail	Size of nail	Wood group of skid		
		II	III	IV
Sinker or cooler	7d 8d or 9d 10d 12d	23 19 18 15	26 21 19 16	19 16 14 12
Corker	7d 8d or 9d 10d 12d	24 17 15 15	26 19 16 16	19 14 12 12

*Nails shall not be less than 2 per board (lumber sheathing) and shall neither be more than 3 inches apart not less than 1-1/2 inches apart.

Member Selection

The sizes of the upper and lower frame members and struts shall be determined from tables 6-34 to 6-43, except as otherwise specified. Loads referred to in the tables shall be the inside measurements of the crate. The member sizes shall be based on Groups II woods. If the exact size of the crate is not given in the tables, member sizes for the crate of the nest greater length and width, and smaller height, shall be used.

Upper and Lower Frame Members

The requirements for upper and lower frame members shall comply with those described for lumber-sheathed side panels in and listed by size in tables 6-34 to 6-43.

Vertical Struts

The requirements for struts shall comply with those described for lumber-sheather side panels and listed by sizes in table 6-34 to 6-43.

Diagonals

No diagonals are required for Class 2 crates.

Joist Supports

The joist supports shall comply with those described for class 1 side panels.

Liners

No liners are required for Class 2 crates.

Sheathing

Plywood sheathing shall be 3/8 inch thick for net loads up to 10,000 lb, and 1/2 inch of net loads over 10,000 lb, and shall be applied so that the face grain is vertical. Face grain may be horizontal for crates 4 feet or less in height. Vertical joints in plywood sheathing shall be made over the center of a strut. Horizontal joints in plywood sheathing shall not be permitted in Type C panels. All horizontal joints shall be made over the center of a horizontal brace.

Fabrication Nailing

Nailing plywood sheathing to frame members of various widths shall be as shown in figure 6-80. For all fabrication, nails shall be driven through the plywood and clinched a minimum of 1/4 inch. Staples may be used to fasten plywood sheathing to framing members.

Lag-screw Reinforcing Strap for Bolted Crates

Reinforcing straps shall be used on side and end panels of all bolted crates as shown in figures 6-77 to 6-79.

Ends

Panel types and sizes of members for ends shall be determined in a manner similar to the sides, except that in all cases, the thickness of the upper and lower frame members shall be the same as the struts specified in table 6-34 to 6-43. The member arrangement shall be as shown in figure 6-81. Fabrication shall be as shown on figure 6-80.

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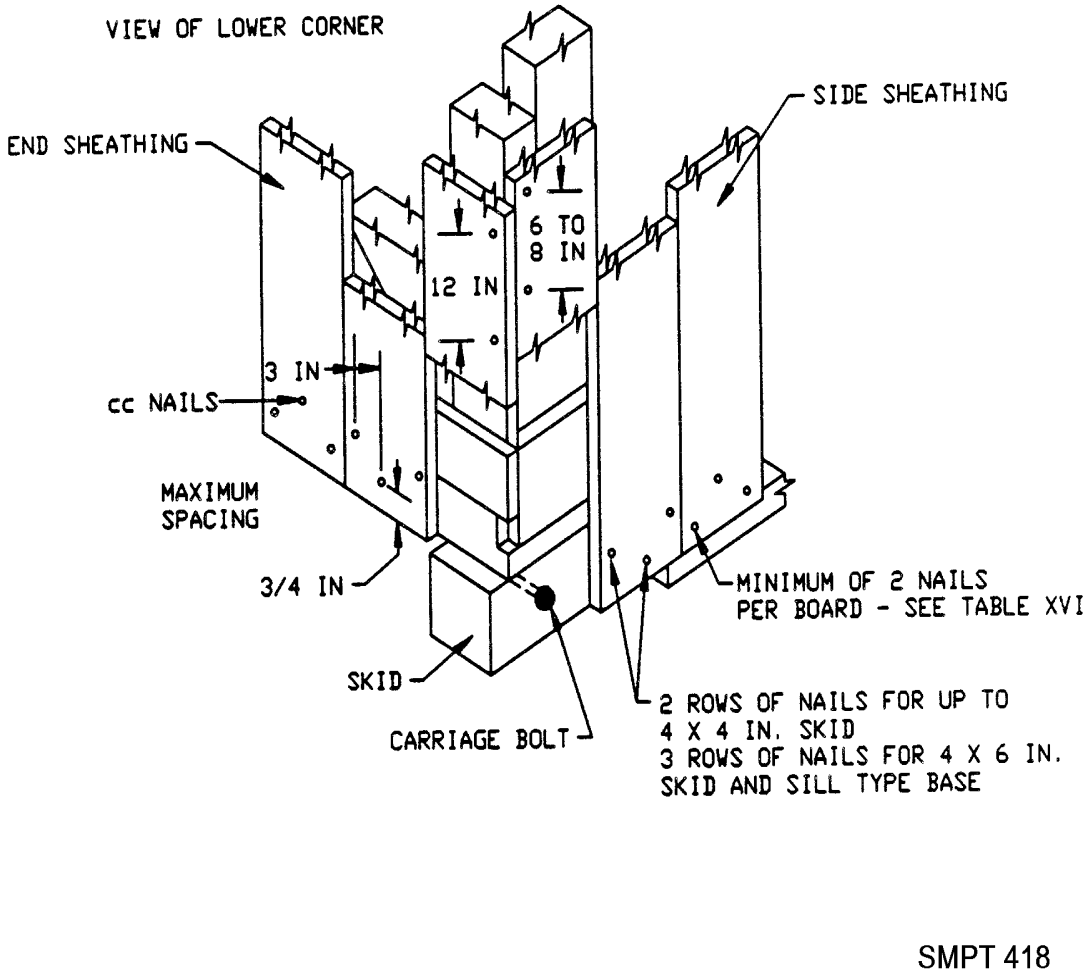
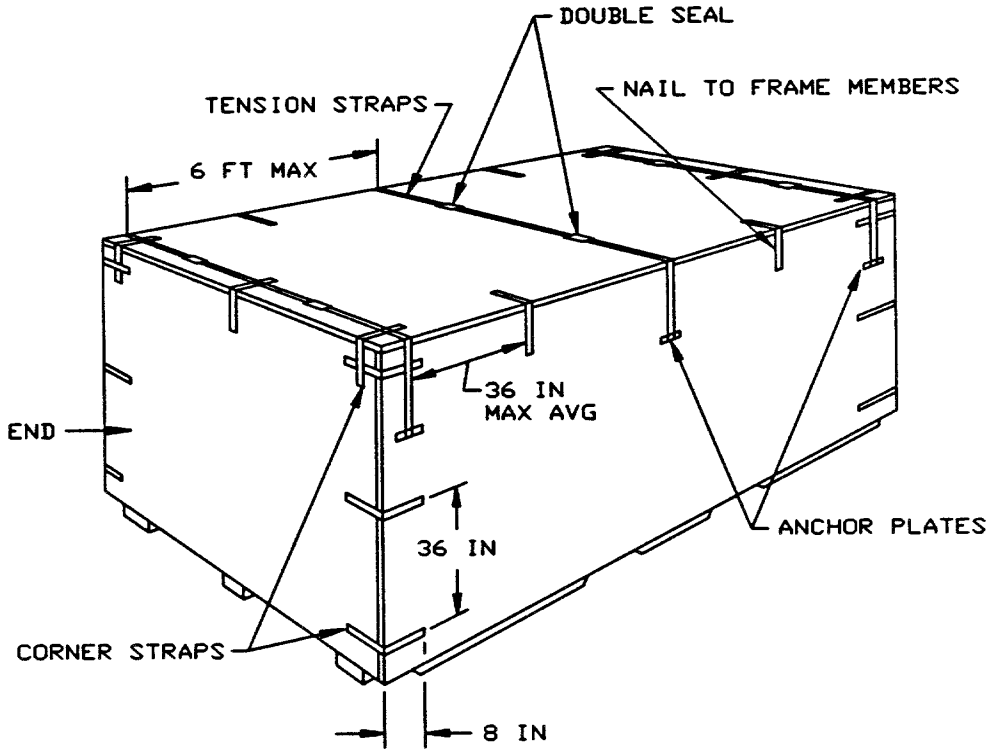


Figure 6-74. Assembly of nailed crate, lumber or plywood sheathing (MIL-C-104).

MIL-C-104C



Notes:

1. Strapping required for all nailed crates.
2. For bolted crates with net loads over 3000 pounds, use corner straps only.

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Figure 6-75. Corner and top strapping, (lumber or plywood sheathing (MIL-C-104).

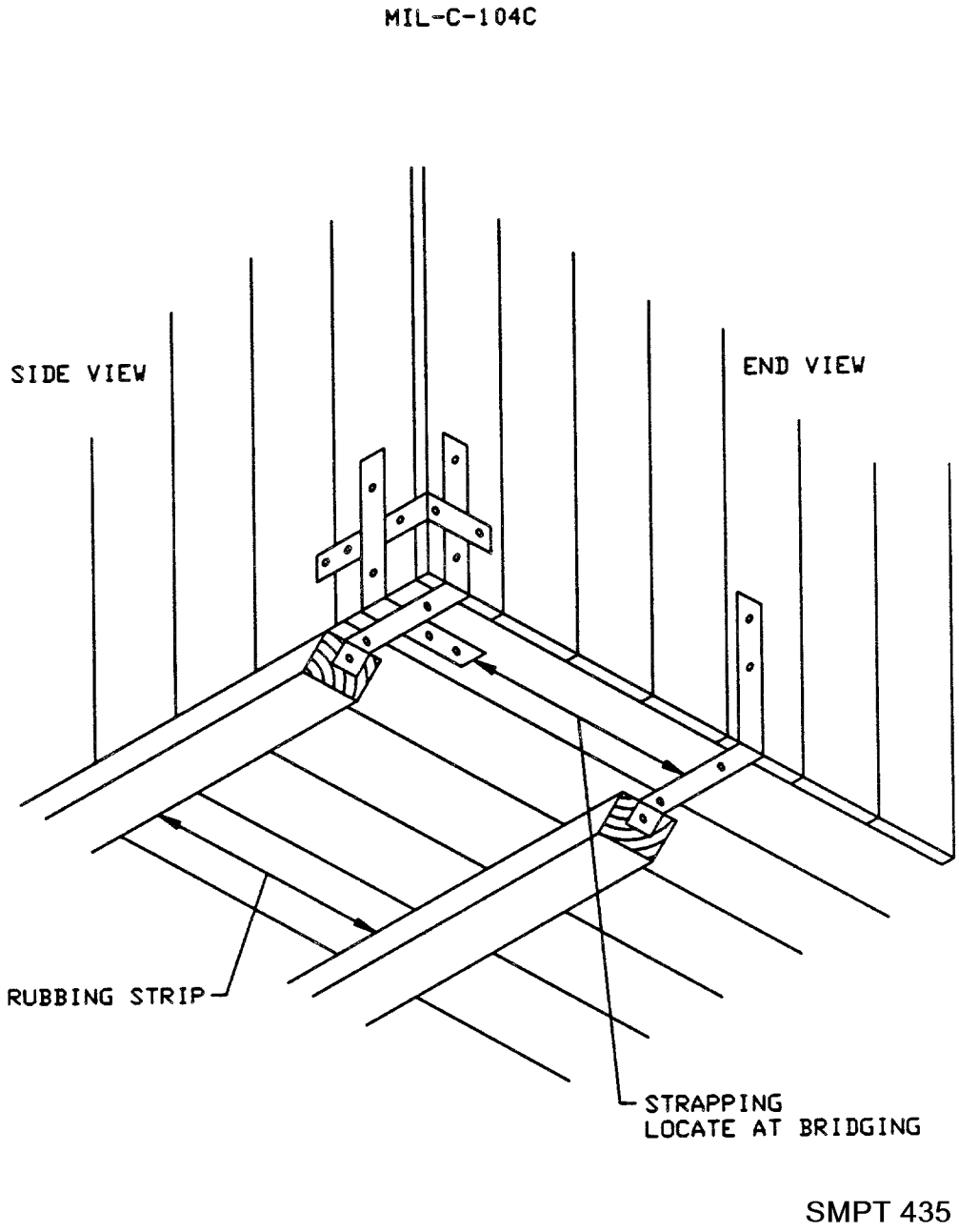


Figure 6-76. Sill base strapping (MIL-C-104).

ASSEMBLY (CLASS 2 CRATES)

Bolted-crate Assembly

The assembly of plywood-sheathed nailed crates shall comply with the details specified for Class 1 crates except for size of nails which shall be as specified in table 6-45.

Reinforcing Straps

The reinforcing straps shall be as specified for Class 1 crates.

Tolerances

A tolerance of plus or minus 1/8 inch is allowable on the overall length and width of individual completed crate panels. Out-of-square deviation of individual panels shall be not more than 3/16 inch (3/8 inch difference in diagonals).

Workmanship

Crate panels shall be clean and free of slivers and protruding fastener points. Crate panels shall be square and free of cracks, splits, or other damage which would prevent easy and correct assembly and adversely affect the performance of assembled crates.

Fire Retardant

When specified, all lumber and plywood shall be treated in accordance with MIL-L-19140. Special markings shall be used to indicate the lumber and plywood have been treated with non-leachable fire retardant materials.

CRATE, SLOTTED ANGLE, STEEL OR ALUMINUM (ASTM D6255)

DESIGN REQUIREMENTS

The slotted angle crate is designed to permit rapid fabrication of a crate through assembly of slotted angle steel or aluminum with nuts, bolts, and lockwashers and disassembly and reuse of component material.

Classification

The following classifications have been established for this crate.

Types

Type I - crate, slotted angle, steel or aluminum, open.

Type II - crate, slotted angle, steel or aluminum, full enclosed or sheathed with solid material.

Styles

Style A - crate, slotted, angle, steel, or aluminum, without skids or rubbing strips.

Style B - crate, slotted angle, steel, with skid blocks or skids with rubbing strips and provisions for forklift truck handling.

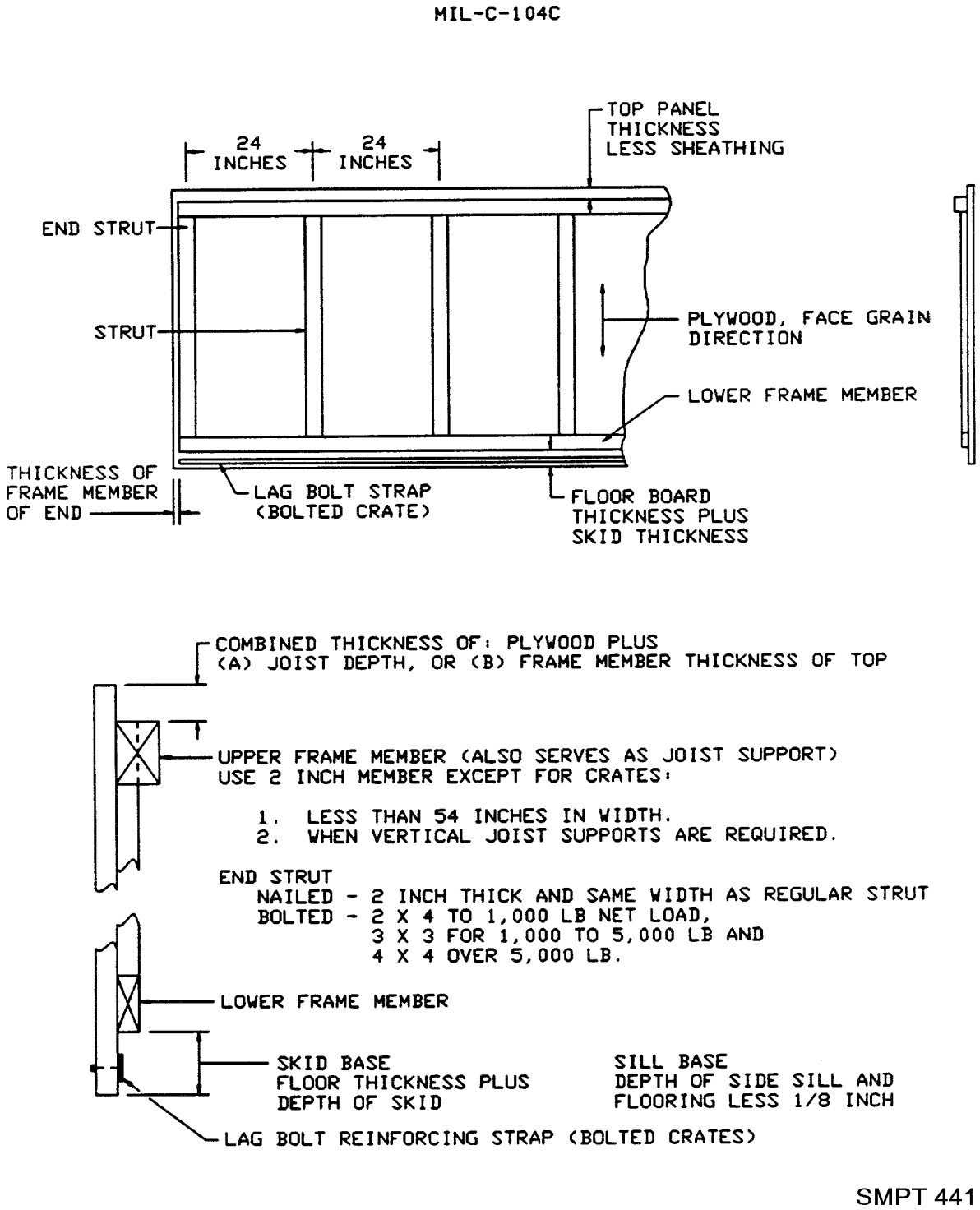


Figure 6-77. Sides - type A panel (plywood) (heights over 24 inches to 60 inches) (MIL-C-104).

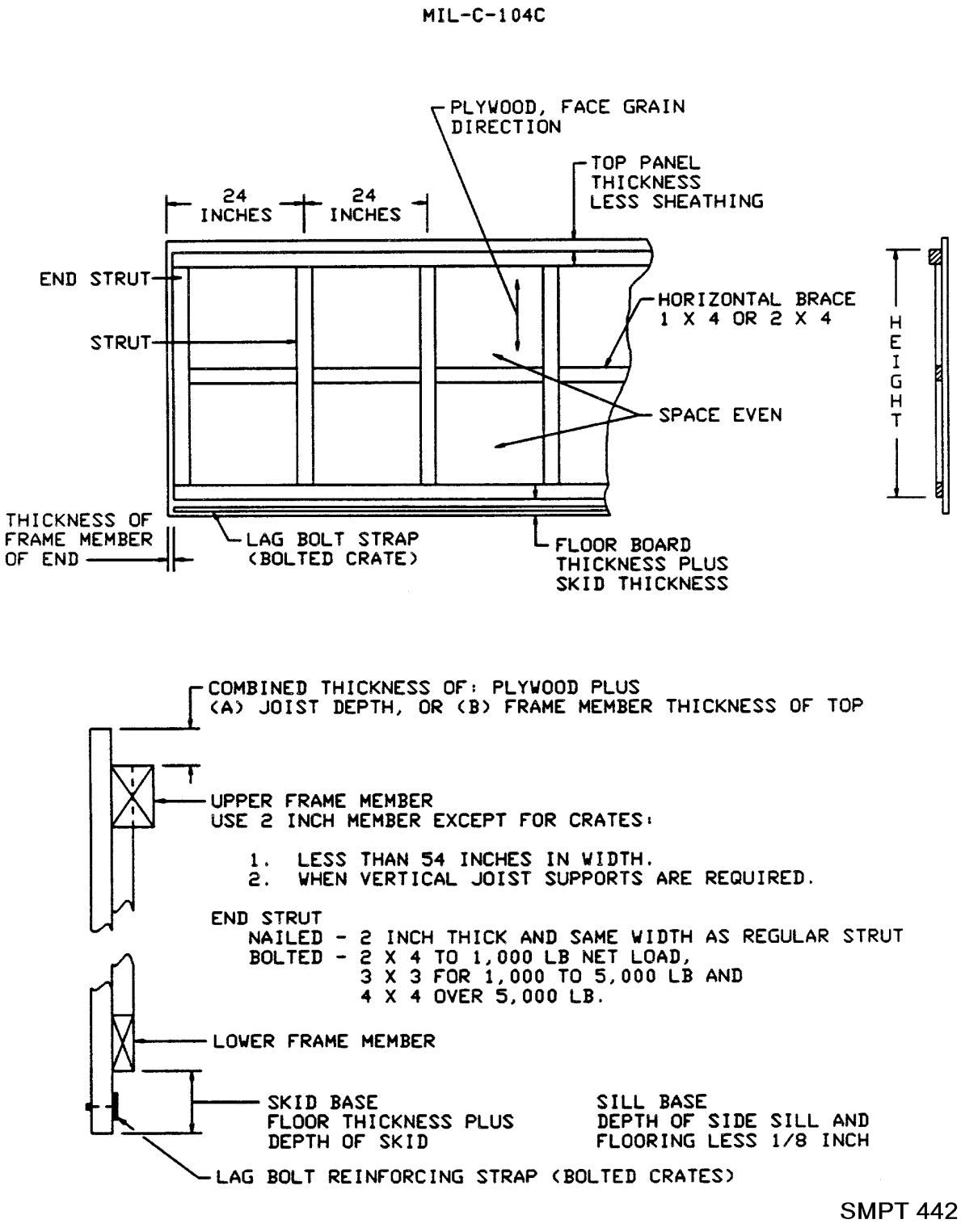


Figure 6-78. Sides - type B panel (plywood) (heights over 60 inches to 96 inches) (MIL-C-104).

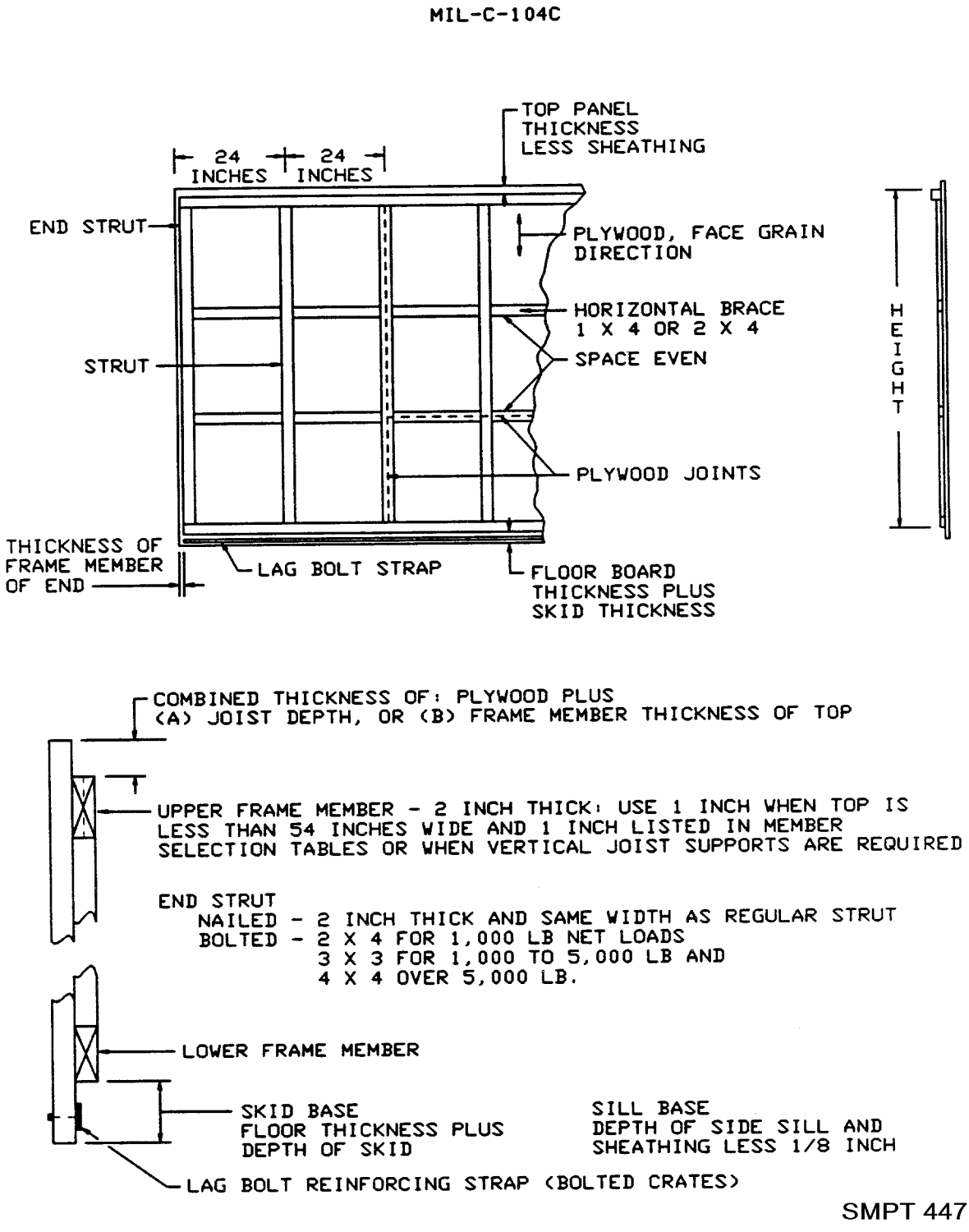
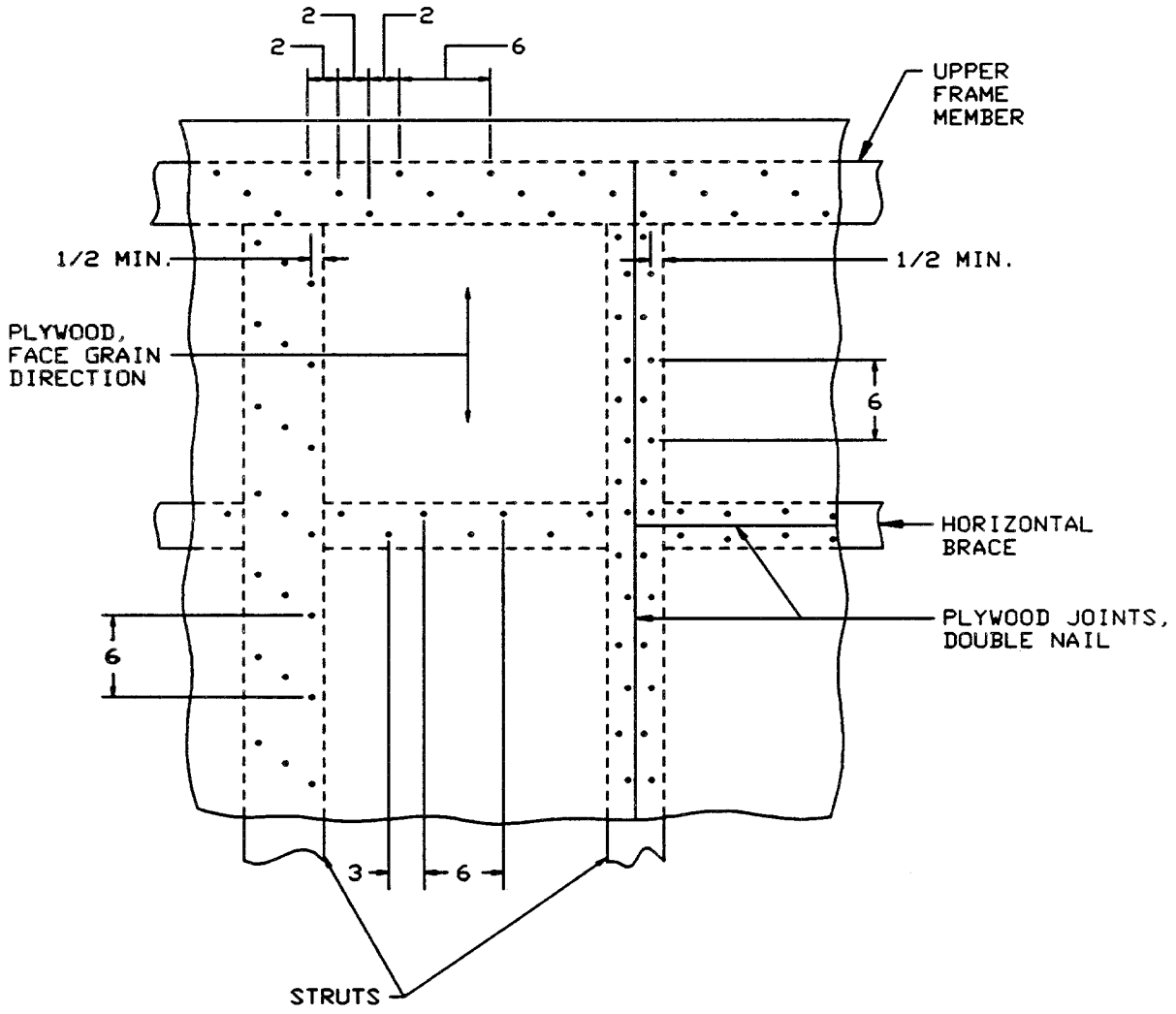


Figure 6-79. Sides - type C panel (plywood) (heights over 96 inches to 144 inches) (MIL-C-104).

MIL-C-104C



Notes:

1. All dimensions are in inches.
2. 3 rows of nails for all members over 4 inches wide.
3. 2 rows of nails for all members up to 4 inches wide.

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Figure 6-80. Fabrication nailing plywood sheathing (MIL-C-104).

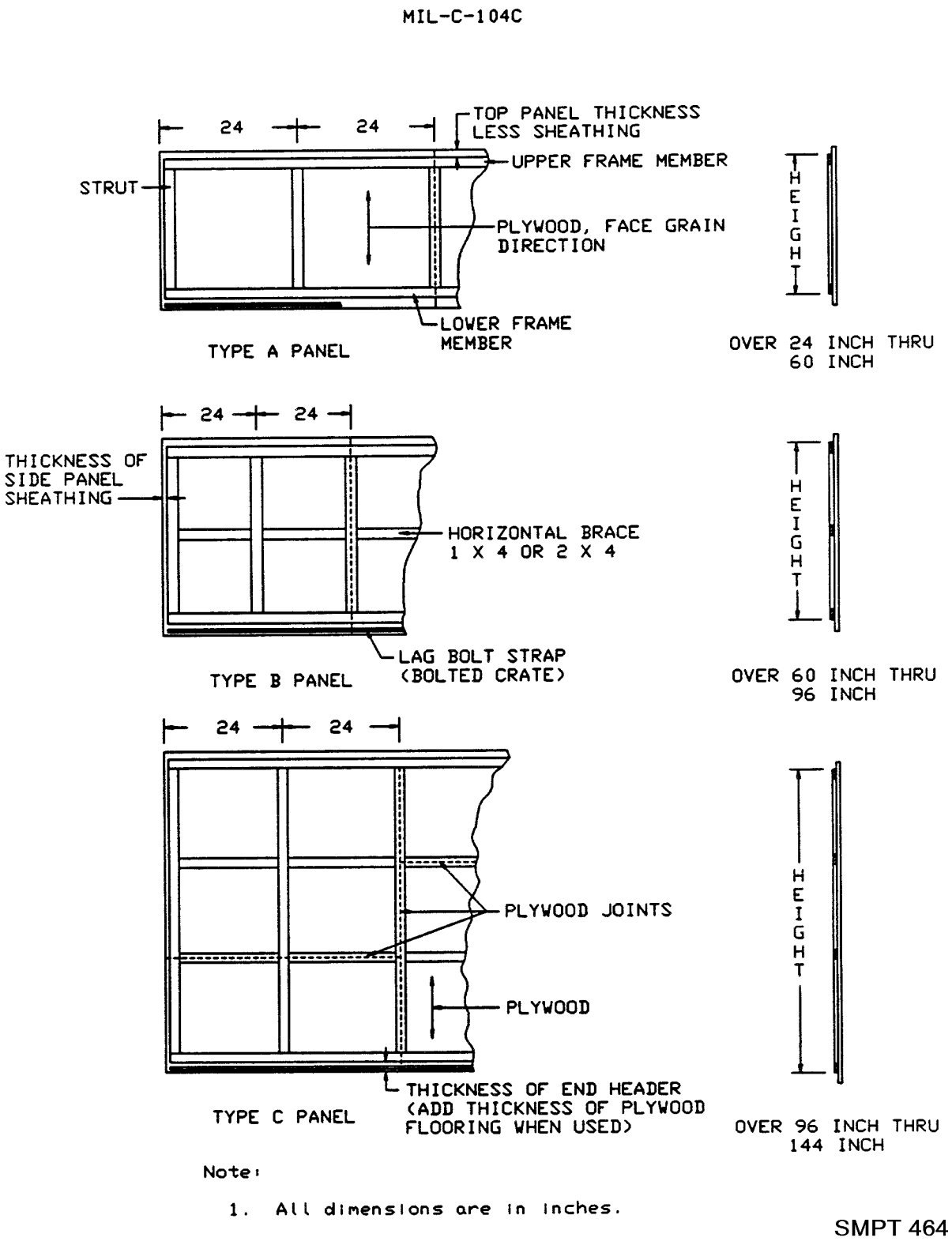


Figure 6-81. End panels plywood sheathing crates (MIL-C-104).

Grades

Grade 1 - Crate for domestic and oversea shipments intended for outside or indeterminate storage.

Grade 2 - Crate for domestic and oversea shipments intended for inside or protected storage.

Use

These crates are suitable for:

- Packing lightweight, bulky items, including airframe components.
- Oversea and domestic air and surface shipments.
- Packing items requiring rigid blocking and bracing assemblies, such as support panels, cushioned saddles, solid and slat cradles, specially designed brackets, yoke panel assemblies, etc.
- Adaptation of suspension systems or shock mounts for shock absorption.
- Packing repairable, returnable items where a desirable light-weight, reusable container is specified.

Materials

Slotted metal angles

This material comes in either steel or aluminum. There are three different sizes of slotted metal angles, variations being based on the size of the flanges and the thickness of the metal used in fabricating the angles. The slotted angle material shall conform to Specification MIL-S-21041, as a guide for the selection of slotted angle based on size of crate and weight of load.

Steel slotted angle material for Grade 1 crates shall have a zinc protective coating. Steel slotted angle material for Grade 2 crates shall be treated with a primer or a phosphatized base and a baked-on synthetic enamel of high grade commercial quality. The color shall be DOD Gray, unless otherwise specified, in accordance with Federal Standard 595.

The hole pattern for the 1-1/2-inch by 1-1/2-inch angle shall be of such a design as to provide one line of holes or slots in each flange. The 1-1/2-inch by 2-1/4-inch angle shall have one line of holes or slots in the narrow flange and two lines of holes or slots in the wide flange. The 1-1/2-inch by 3-inch angle shall have one line of holes or slots in the narrow flange and three lines of holes or slots in the wide flange. The hole pattern shall be of continual repetition and shall be visually indexed at 3-inch intervals.

Occasionally, it may be necessary to splice pieces. When this occurs, either the lap or butt splice may be made.

Bolts and Nuts

Bolts and nuts used in joining slotted angle frame members of the crate shall conform to Specification MIL-S-21041, except that nuts shall conform to MS51922 with the exception that 5/16 nuts shall be .551 to .564 inches across the flats.

Bolts and nuts used in attaching sheathing and wood members of the crate (and any wood blocking and bracing therein) shall be fastened to a slotted angle material with not less than two bolts on each panel edge, with additional bolts being employed, if necessary, to maintain the interval between bolts at not more

than 12 inches. When sheathing is attached to the top by nailing to a wooden strip which is secured to the slotted angle portion of the crate by bolts spaced not less than 24 inches apart, the nailing strip will be at least 1 by 2 inches and the nails will be at least sixpenny in size, spaced not more than 5 inches apart.

Ventilation

Crates completely enclosed or sheathed with plywood or paper-overlaid veneer will be ventilated. Ventilation will be accomplished by means of holes or slots in the ends or ends and sides around the perimeter of the crate. They shall be place immediately below the tip frame members of the ends and sides. When crates are over 10 feet in length, the ventilation holes or slots will be divided equally between both ends and both sides and located as near the midpoint of the sides and ends as practicable. Place baffles or shields inside the crate to deflect the water blowing into the crate, thus preventing the water from coming in contact with the contents. The following table establishes the area of the holes or slots required to provide ventilation for graduated range of volume for a crate (table 6-47).

Panels for Marking Open Crates

To provide sufficient area for placing required markings on open crates, a panel of 1/4-inch plywood will be bolted to the crate.

Specific Crates

Type 1, Style A

This crate is of simple construction, usually consisting of one panel in each section, requiring minimum bracing and used for light, bulky, and small items not exceeding 200 pounds. Either the slotted angle aluminum or the smaller slotted angle steel is usually strong enough of this crate. Unless specifically excepted, it is limited to maximum dimensions of 80 inches in width.

Table 6-47. Ventilation requirements

Area of holes or slots for ventilation	
Volume of crate in cubic feet	Cumulative area in square inches of ventilation holes or slots
0-106.....	7
106-141.....	10
141-176.....	13
176-388.....	27
388-600.....	33
600-777.....	54
777-989.....	66
989-1236.....	81
1236-and over....	101

Sides

The metal angle used for the side rails (horizontal members) should be positioned with the wider flange parallel to the plane or surface of the side. The bottom rail should be positioned so that the wide flange points up, while the top rail should have the wide flange pointing down. Vertical members (struts) should be equal in length and be positioned so that they are within horizontal rails when the crate is assembled. Vertical members should not exceed 48 inches in length and distance between vertical members (struts and intermediate struts) shall not exceed 1-1/3 the height of the crate. Where greater side strength or special mounting provisions are required along the side of the crate, extra vertical members may be added with the wide flange against the wide flange of the horizontal members (side rails) of the crate. Additional or intermediate vertical members should be added where the length-to-height ratio dictates.

Ends

The crate ends shall consist of slotted angle crossmembers joining the two crate sides. Additional crossmembers joining the two crate sides. Additional crossmembers or intermediate struts to provide mounting or attaching points within the crate for specific items may be added to crate end as required. The distance between the lateral members (crossmembers and intermediate struts) shall not exceed 1/1/3 the width of the crate.

Base

The base is not a separate panel which is bolted to the sides and ends, but is formed by the addition, as necessary, of crossmembers, (loadbearing members, flooring, and braces).

Flooring

The crate will be sufficiently floored to protect the contained item. The flooring need not be continuous throughout the base; however, it will be placed in such locations that will provide protection to the areas of the contained item that are subject to damage by forklift trucks or other material handling equipment. Plywood flooring (except loadbearing floorboards) will be a minimum of 1/4 inch thick for crates through 12 inches wide 3/8, inch for crates over 12 inches wide and through 24 inches wide, and 3/4 inch thick for crates over 24 inches wide. Flooring will be cut to fit snugly in place and securely bolted to the lower side rails of the crate. Each piece of flooring shall be bolted in place with a minimum of two bolts in each lower side rail. The distance between bolts used to secure the flooring shall not exceed 12 inches. When the flooring is 3/8 inch or less in thickness it is reinforced on top by an additional strip of wood 1 X 2, through which the holddown bolt will pass. Bolts used of securing floorboards shall not be less than 5/16 inch in diameter.

Loadbearing Members

Loadbearing members shall be located within the crate base to carry the load of the contained item, except when suspensions systems are used or when the item is attached to the side structure. The size of wood members shall be determined from table 6-48. The size of steel members shall be determined from table 6-49.

Crossmembers

Crossmembers will be of the same strength and quality as the slotted angle used of the side rails and struts. Crossmembers in the base will be spaced not more than 24 inches apart. If loadbearing members are employed, they should be included in the considerations for base crossmembers.

Braces

The base should be reinforced with braces of the same slotted angle as the crossmembers. These braces should be used in unfloored areas of the crate. When one-third of the base is floored with 12-inch or wider floor panels, braces are not required.

Crate Top

The top, like the base, is not a separate panel which is attached to the sides and ends. It is formed by crossmembers, crossties members, and braces installed between the two crate sides. The crossmembers are placed perpendicular to the sides and are placed at each point where a vertical strut is bolted to the side rail, being bolted as shown in figure 6-82. Alternate methods of attaching members are shown in figure 6-83. The crosstie members are slotted angle members placed at intermediate points between, and parallel to, crossmembers with the distance between the crossmembers and crossties not exceeding 1-1/3 the width of the crate. Braces of the same type slotted angle material as that used for crossmembers are placed diagonally in the rectangle formed by the side rails and the crossmembers and crossties. The ends will be cut at an angle to give maximum contact of the flanges being bolted together.

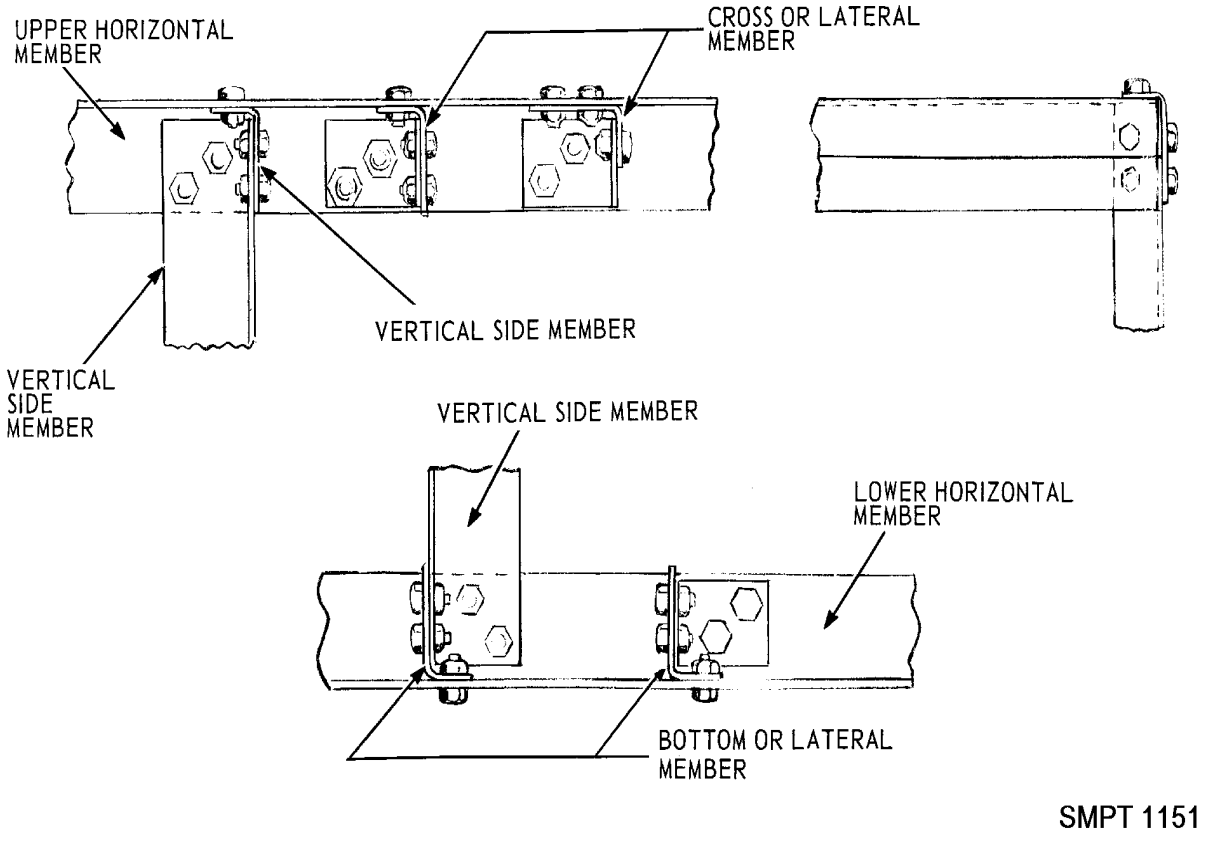


Figure 6-82. Joining of Intermediate members (ASTM D6255).

Table 6-48. Allowable Load per inch of floorboard width for Groups II, III and IV woods

Distance between outside skids	Actual thickness of floorboards (inches)			
	3/4	1-1/2	2-1/2	3-1/2
(inches)	(pounds)	(pounds)	(pounds)	(pounds)
12	48	220	574	1,095
18	32	147	382	731
24	24	110	287	548
30	19	88	229	438
36	16	73	192	365
42	14	63	164	313
46	12	55	144	274
59	9	44	115	219
72	8	37	96	182

If groups III or IV woods are used, the above allowable loads may be increases 20 percent.

Table 6-49. Load capacity of slotted angle steel beams. 1/
SLOTTED ANGLE STEEL - 2.6mm - 38mm X 76mm
(12 GUAGE (0.014") - 1-1/2" x 3")
(Length of beam in cm (feet) - load in kg (pounds))

	60(2)	90(3)	120(4)	150(5)	180(6)
Recommended load	659(1450)	445(980)	336(740)	227(500)	150(350)
Recommended load	2045(4500)	1409(3100)	954(2100)	545(1200)	454(1000)
Recommended load	4727(10400)	3409(7500)	2409(5300)	1977(4350)	1590(3500)
Recommended load	704(1550)	454(1000)	345(760)	263(580)	222(490)

SLOTTED ANGLE STEEL - 1.9mm - 38mm X 57mm
(14 GUAGE (0.074") - 2-1/2" x 2-1/4")
(Length of beam in cm (feet) - load in kg (pounds))

	60(2)	90(3)	120(4)	150(5)	180(6)
Recommended load	572(1260)	386(850)	277(610)	181(400)	90(200)
Recommended load	1090(2400)	772(1700)	522(1150)	372(820)	284(625)
Recommended load	2359(5190)	1522(3350)	1227(2700)	954(2100)	772(1700)
Recommended load	363(800)	231(510)	177(390)	136(300)	113(250)

1/ Table 49 is usable for slotted angle steel with flange dimensions that are plus or minus 3mm (1/8 inch) the flange sizes stated.

Table 6-49a. Load capacity of slotted angle steel beams. 1/
SLOTTED ANGLE STEEL - 1.9mm - 38mm X 38mm
(14 GUAGE (0.074") - 1-1/2" x 1-1/2")
(Length of beam in cm (feet) - load in kg (pounds))

	90(3)	120(4)	150(5)	180(6)
Recommended load	225(495)	122(270)	86(190)	65(145)
Recommended load	268(590)	179(395)	134(295)	86(190)
Recommended load	606(1335)	470(1035)	313(690)	245(540)

1/ Table 49a is usable for slotted angle steel with flange dimensions that are plus or minus 3mm (1/8 inch) the flange sizes stated.

Table 6-49b. Load capacity of slotted angle steel beams. 1/

SLOTTED ANGLE STEEL - 1.9mm - 38mm X 38mm
(14 GUAGE (0.074") - 1-1/2" x 1-1/2")

(Length of column in cm (feet) - load in kg (pounds))

	90(3)	120(4)	150(5)	180(6)
Recommended load	672(1480)	536(1180)	427(940)	336(740)
Recommended load	1740(3830)	1579(3475)	1350(2970)	1125(2475)
Recommended load	1772(3900)	1620(3565)	1440(3170)	1190(2620)

1/ Table 49b is usable for slotted angle steel with flange dimensions that are plus or minus 3mm (1/8 inch) the flange sizes stated.

Table 6-49c. Load capacity of slotted angle steel columns. 1/(Continued)
SLOTTED ANGLE STEEL - 1.9mm - 38mm X 57mm
(14 GUAGE (0.074") - 1-1/2" x 2-1/4")

(Length of beam in cm (feet) - load in kg (pounds))

	90(3)	120(4)	150(5)	180(6)	210(7)
Recommended load	1131(2490)	840(1850)	695(1530)	581(1280)	427(940)
Recommended load	2500(5500)	2272(5000)	1977(4350)	1727(3800)	1522(3350)
Recommended load	2545(5600)	2450(5390)	2272(5000)	2036(4480)	1186(4150)

SLOTTED ANGLE STEEL - 2.6mm - 38mm X 76mm
(12 GUAGE (0.104") - 1-1/2" x 3")

(Length of beam in cm (feet) - load in kg (pounds))

	90(3)	120(4)	150(5)	180(6)	210(7)
Recommended load	1568(3450)	1304(2870)	1072(2360)	759(1670)	522(1150)
Recommended load	3618(7960)	3200(7040)	2836(6240)	2454(5400)	2045(4500)
Recommended load	4045(8900)	3609(7940)	3045 (6700)	2636(5800)	2113(4650)

1/ Table 6-49c is usable for slotted angle steel with flange dimensions that are plus or minus 3mm (1/8 inch) the flange sizes stated.

TABLE 6-49d. Load capacity of slotted angle aluminum configurations. 1/
SLOTTED ANGLE STEEL - 2.6mm - 38mm X 57mm
(13 GUAGE (0.089") - 1-1/2" x 2-1/4")
(Length of beam in cm (feet) - load in kg (pounds))

	90(3)	120(4)	150(5)	180(6)
Recommended load	204(450)	159(350)	118(260)	81(180)
Recommended load	431(950)	272(600)	2/181(400)	2/159(350)
Recommended load	100(2200)	727(1600)	563(1240)	427(940)

SLOTTED ANGLE STEEL - 1.9mm - 38mm X 57mm
(13 GUAGE (0.089") - 1-1/2" x 2-1/4")
(Length of beam in cm (feet) - load in kg (pounds))

	90(3)	120(4)	150(5)	180(6)	210(7)
Recommended load	454(1000)	409(900)	318(700)	272(600)	
Recommended load	1409(3100)	1240(2730)	1104(2430)	986(2170)	795(1750)
Recommended load	1590(3500)	1409(3100)	1227(2700)	1090(2400)	954(2100)

1/ Table 6-49d is usable for slotted angle aluminum with flange dimensions that are plus or minus 3mm (1/8 inch) the flange sizes stated.
2/ On spans of this length, cross bracing gives a better structure, higher recommended load.

Use of Corner Braces for Light Crates

Where crates are intended for net loads not in excess of 200 pounds and limited to the maximum dimensions of 60 inches in length, 30 inches in width, and 48 inches in height, corner bracing may be utilized in lieu of full diagonal bracing.

Type II, Style A Crate

This crate is identical to the Type I, Style A crate, except that it is fully closed or sheathed using plywood, paper-overlaid veneer, or fiberboard, as specified above. Sheathing should be added.

Type I, Style B Crate

The Style B (skidded) crate is intended for use in crating larger and/or heavier items, employing a skidded base; braced sides, ends and top; loadbearing and attaching members; and provisions for truck and cargo sling handling. Only slotted angle steel (not aluminum) will be used in fabricating this style crate.

Unless specific approval is given for a larger size crate, the maximum dimensions are 360 inches in height (see figure 6-86 for a typical crate).

Sides

Crate sides consist of horizontal members (side rails), vertical members (struts), and full diagonal braces.

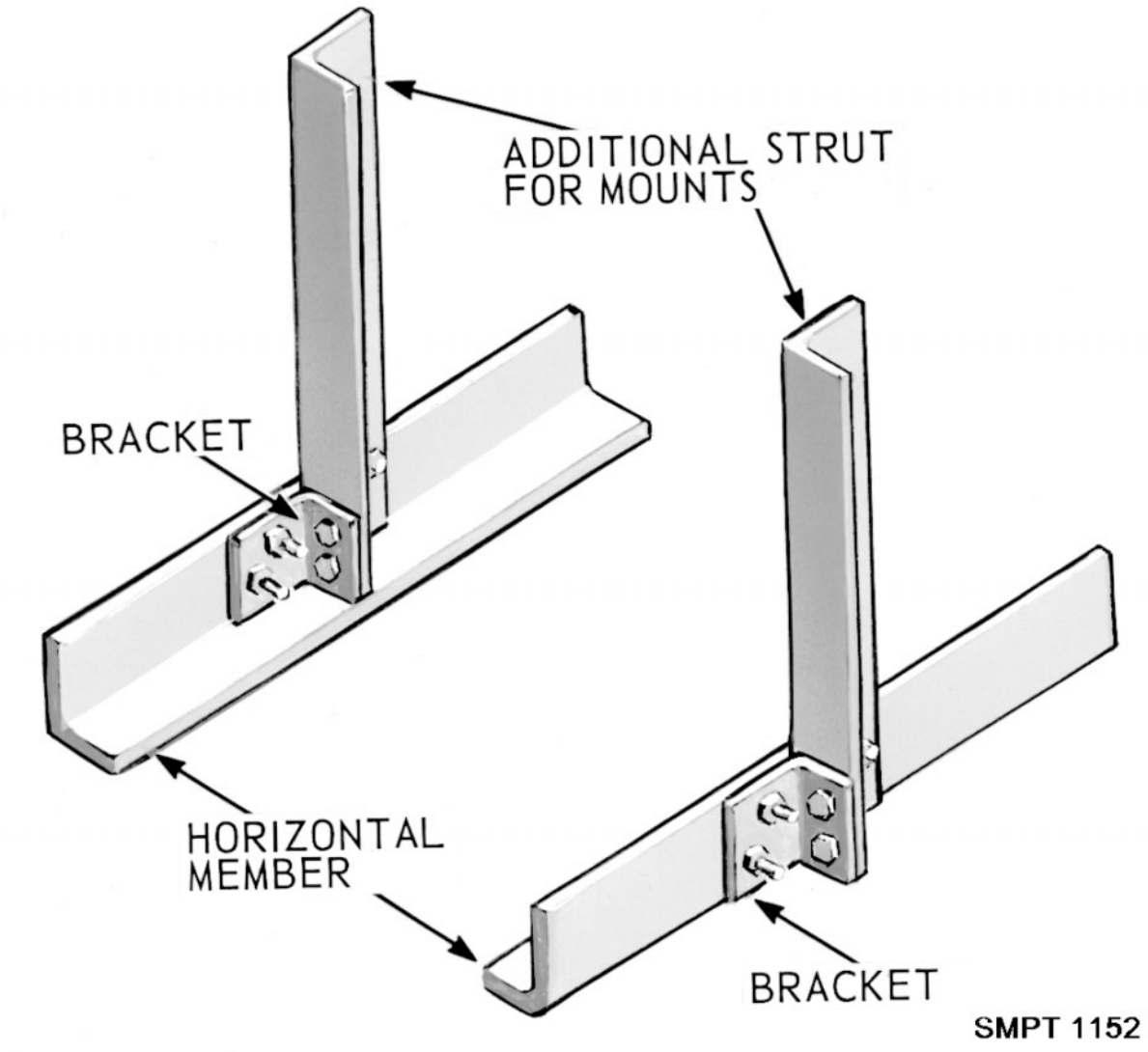


Figure 6-83. Alternate methods of attaching members (ASTM D6255).

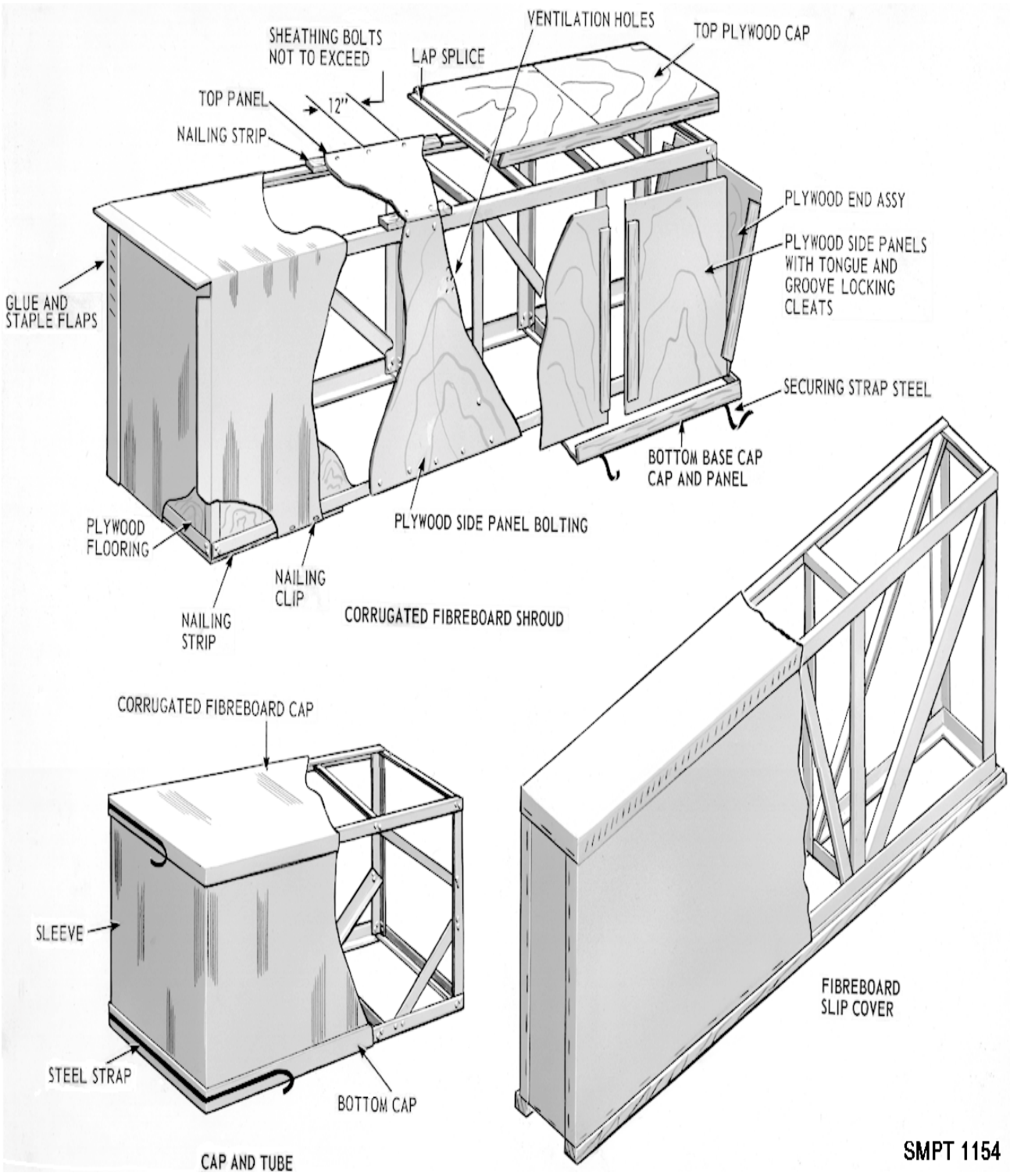


Figure 6-84. Methods of sheathing or covering crates (ASTM D6255).

Intermediate Horizontal Members

When a crate exceeds 48 inches in height, and intermediate horizontal member should be placed between the top and bottom side rails and should run the full length of the crate. In addition to the requirement for additional intermediate horizontal members because of the height, extra strength requirements may demand additional horizontal members.

Intermediate Vertical Struts

Intermediate struts shall be evenly and systematically spaced throughout the length of the crate side between the end or corner vertical struts. The spacing of intermediate struts for crates with sides not provided with an intermediate horizontal member shall be determined by the height and length. The distance between the vertical struts shall not exceed 1-1/4 the height of the crate. The spacing of intermediate struts for crates with sides provided with intermediate horizontal member shall be determined by the same method as above, except that the height shall be considered as the distance between the two adjacent horizontal members.

Ends

The ends are not assembled panels which are bolted to the sides but are formed by the upper and lower crossmembers, intermediate crossmembers, and braces which join the sides. In addition to the upper and lower crossmembers, intermediate crossmembers are required when the height of the crate exceeds 48 inches or when the height of the crate exceeds 1-1/4 width of the crate. The maximum interval between any two adjacent crossmembers is 48 inches. Intermediate crossmembers shall be installed with the wider flange of the angle in a vertical position. Intermediate vertical members may be added to the ends for special mountings and special blocking and bracing. Bracing of the ends may be done either with slotted angle materials equal to that used for side bracing or with flat steel strapping (as above). When a crate is in excess of 60 inches long, 18 inches wide, or subject to being pushed by forklifts or other equipment, it should be equipped with push plates to protect the crate and contents (figure 6-87). The push plates are positioned across the lower part of the end panel with the lower part of plate flush with top of the skids and shall be bolted to the corner struts with a minimum of two bolts in each end of the plate. Group II, III, or IV wood or plywood may be used for crates having a gross weight up to 500 pounds. They shall be Group III or IV wood when the gross weight exceeds 500 pounds. When push plates are made from wood they shall be a minimum 1-5/8 inches thick and 7-1/2 inches wide. Plywood push plates shall be a minimum 3/4 inch thick and 12 inches wide.

Top

The top, like the ends, if formed by joining the two sides together, through the use of crossmembers, crossties, and braces of slotted angle material. The end crossmembers serve also as the top crossmembers of the ends. Additional crossmembers are bolted as shown in figure 6-84, the wider flange being vertical and the narrow flange at he top. Figure 6-84 and 6-85 show methods which may be used in sheathing or covering crates. When the distance between the crossmembers is greater than 1-1/4 times the width of the crate, intermediate crossmembers (crossties) should be used, pacing them equidistant between the crossmembers. Sufficient crossties should be used to maintain an interval not in excess of 1-1/4 times the width of the crate between any two adjacent crossmembers and/or crossties. Full diagonal braces should be used in the interval between adjacent crossmembers and/or crossties. Tension braces of steel strapping may be used in lieu of slotted angle material.

Base

Crossmembers and crossties tying the side panels together at the bottom of the crate plus required loadbearing members, forklift handling members, skid blocks, full skids, headers, and flooring comprise the base.

Skid Blocks and Full Skids

When the load contained by the crate exceeds 500 pounds, full skids running the length of the crate shall be used. Full length skids may be used for lesser contained weights, but are not mandatory. Full length skids shall be fabricated from minimum nominal 2 X 4 inch lumber for net loads up to 1,000 pounds and 4 X 4 inch lumber for net loads exceeding 1,000 pounds. They shall be provided with 2 X 4 inch rubbing strips. When full length skids are not used, 2 X 4 inch skid blocks 16 inches long are used. Skids and skid blocks shall be beveled 45 degrees on each end. Skid blocks located at the ends of the crate shall be set 2-1/2 to 4 inches from each crate end to permit the use of slings. Rubbing strips on full length skids shall be set back an equal distance from each crate end. Intermediate skid blocks shall be placed in locations that will support loads transferred to the lower side rails by loadbearing members and struts. The center of balance of the loaded crate shall be the determining factor in locating intermediate skid blocks to provide the forklift entry. The maximum distance between skid blocks shall not exceed 48 inches. Skid blocks, skids, and rubbing strips shall be bolted to the lower side rails with minimum 5/16 inch diameter bolts.

Loadbearing Members

To provide direct support to loads resting on the base, loadbearing members are used. These members may be either wood, plywood, metal, or a combination of wood and metal are placed at right angles to the length of the crate, being bolted to both of the lower side members. See tables 6-47 and 6-48 for tabulated data to be used in determining the size, etc., of material for loadbearing members.

Flooring

Flooring may be lumber or plywood and need not be continuous throughout the base; however, it shall be placed in such locations as will provide protection to the areas of the contained item that is subject to damage by forklift trucks or other material handling equipment. The flooring should be cut to fit snugly in place and should be bolted to both of the lower side each end of each piece of flooring with a minimum of two bolts to a rail. Plywood flooring shall have a minimum thickness of 3/8 inch for crates through 12 inches wide, 1/2 inch for crates 12 to 24 inches wide, and 3/4 inch for crates over 24 inches wide. Lumber flooring shall have a minimum thickness of 3/4 inch.

Forklift Handling Members

Forklift handling members of lumber of metal, the side of which is based on strength required as applied to the data shown in tables 6-47 and 6-48, will be placed 24 inches from each end of the crate and at right angles to the length, being bolted to both of the lower side rails. When the crate is in excess of 36 inches in width, forklift handling members should be placed at the location provided for side entry of forklifts and, if the crate is over 8 feet in length, they should be in addition to those placed 24 inches form the end. Loadbearing members, if suitably located, may serve as forklift handling members.

Type II, Style B Crate

Except for the sheathing, this crate is fabricated in the same manner as the Type I, Style B crate. The sheathing is accomplished in the manner described above.

Crossties and Headers

When the distance between loadbearing members exceeds the width of the crate and the flooring is less than 3/4 inch thick, intermediate crossties should be installed, being bolted to both of the flanges of both lower side rails (figure 6-82).

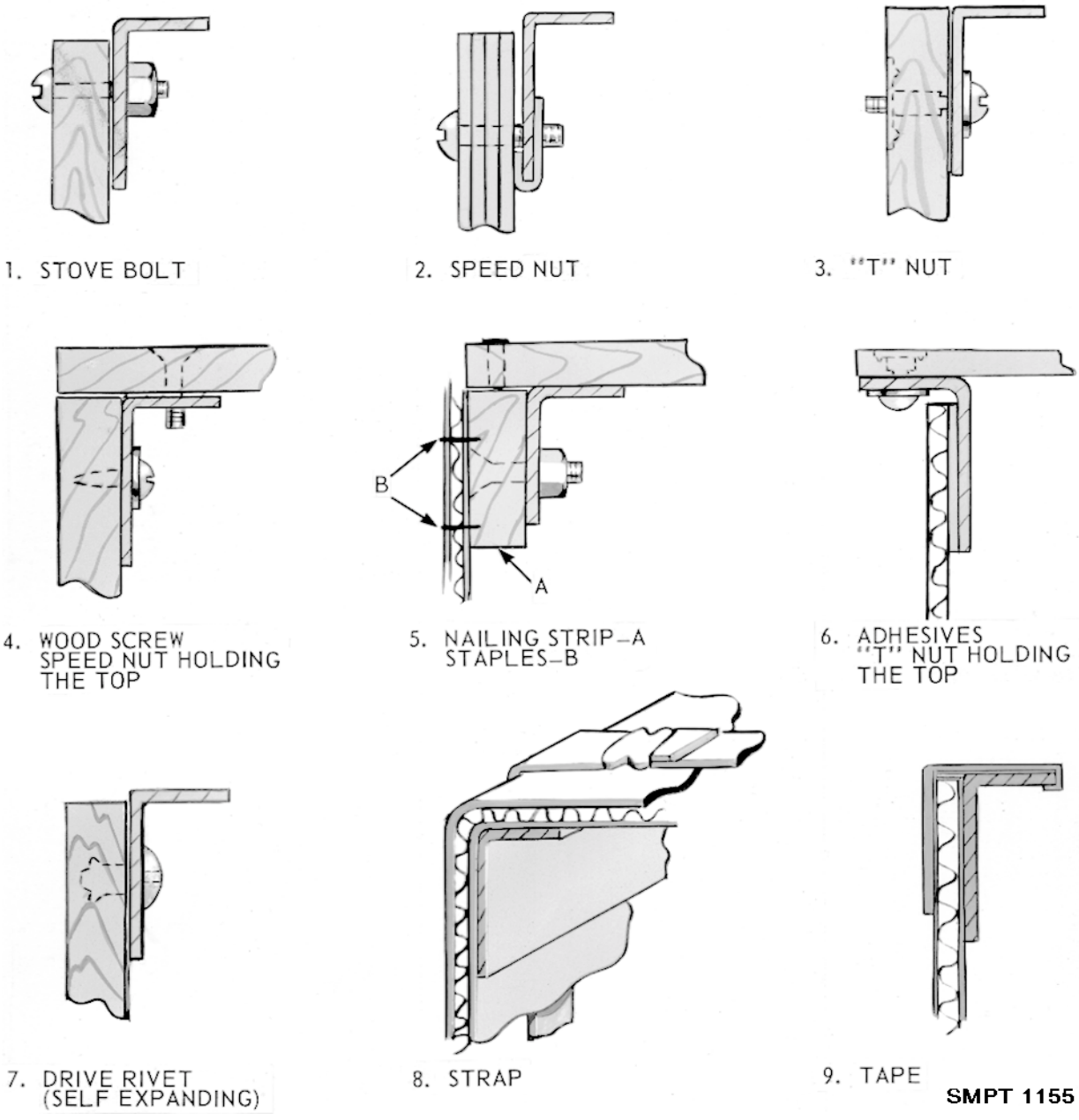


Figure 6-85. Methods of attaching sheathing (ASTM D6255).

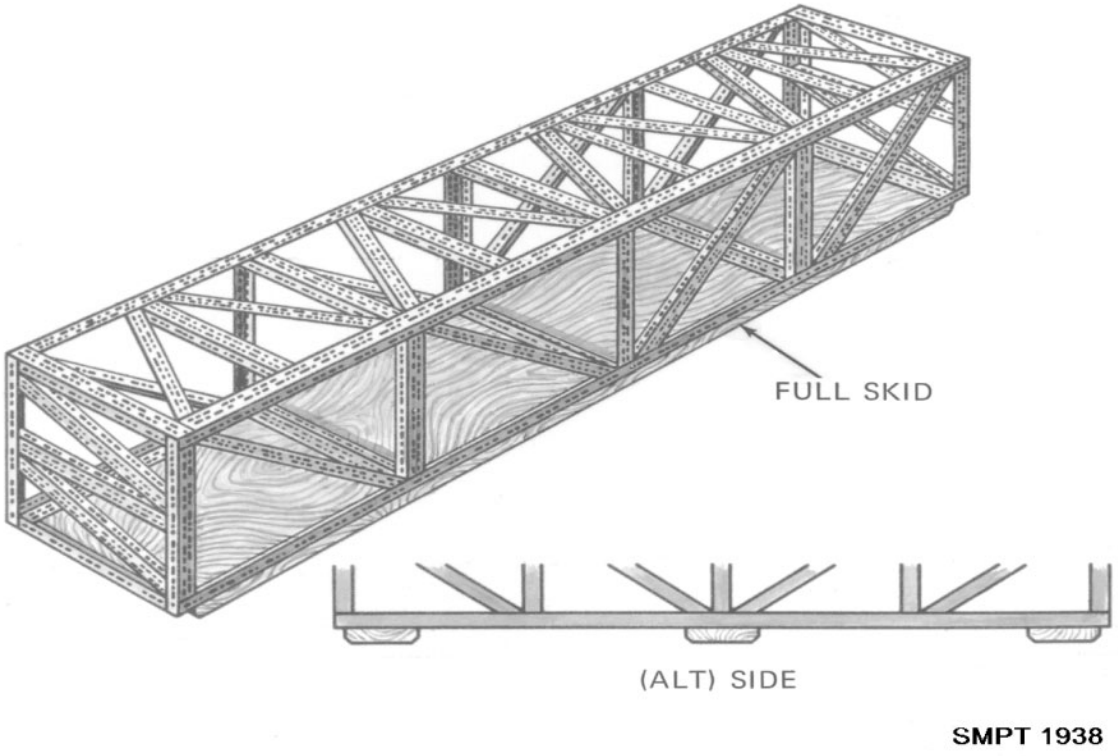


Figure 6-86. Type I, style B crate (ASTM D6255).

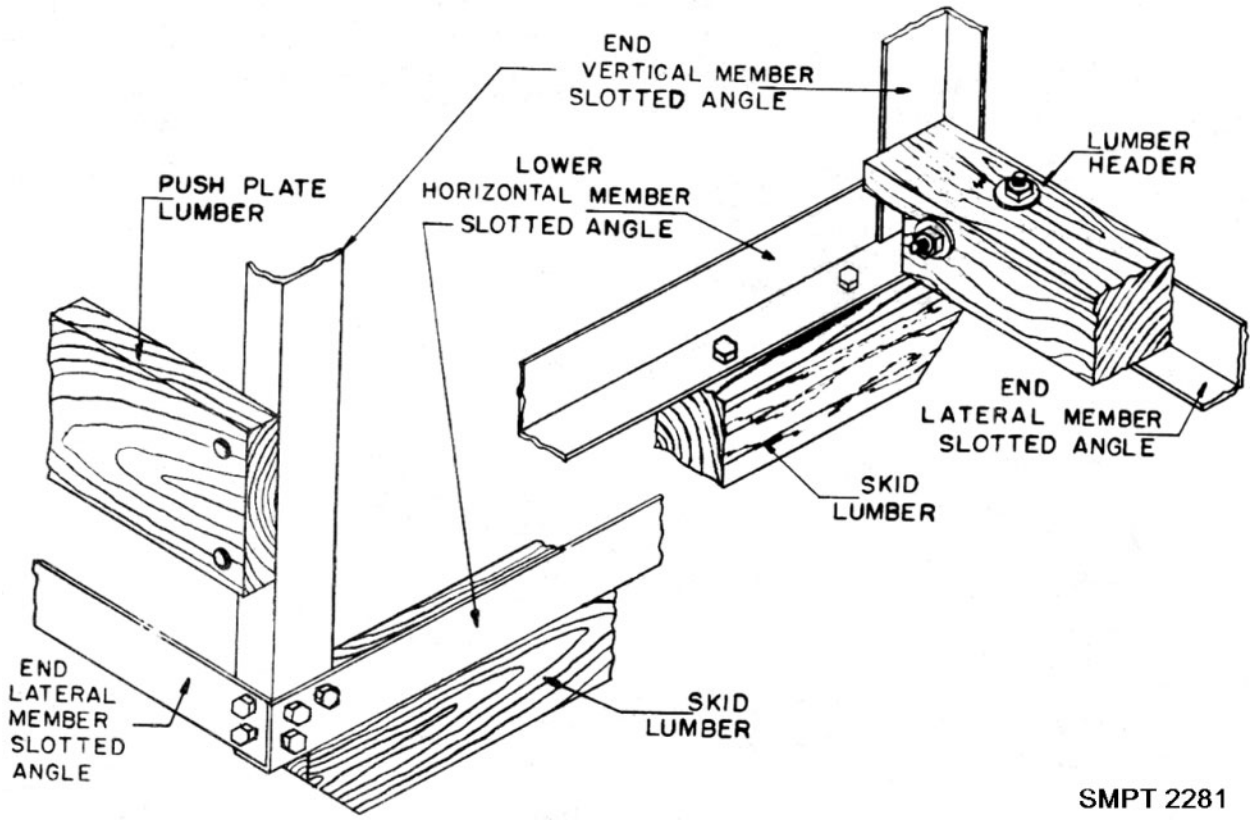


Figure 6-87. Method of attaching push plates, skids, and headers (ASTM D6255).

Chapter 7

CONSOLIDATION AND UNITIZATION FOR SHIPMENT AND USE OF CARGO CONTAINERS

CONSOLIDATION AND UNITIZATION FOR SHIPMENT

Consolidation is the bringing together of like or unlike items for shipment. Once the items are assembled, they must be kept together as a single unit until they reach a break-bulk point or the ultimate consignee. Unitization results in economy through reduction in handling and documentation, one unit taking the place of several units.

ADVANTAGES

Figure 7-1 gives advantages of unitizing loads which are a follows:

- Eliminates laborious and expensive manual handling of individual items.
- Reduces damage to items by eliminating manual handling.
- Permits savings in handling costs.
- Reduces personnel accidents by eliminating manual handling and lifting.
- Simplifies inventorying and reduces inaccuracies.
- Utilizes storage heights not possible by manual means.

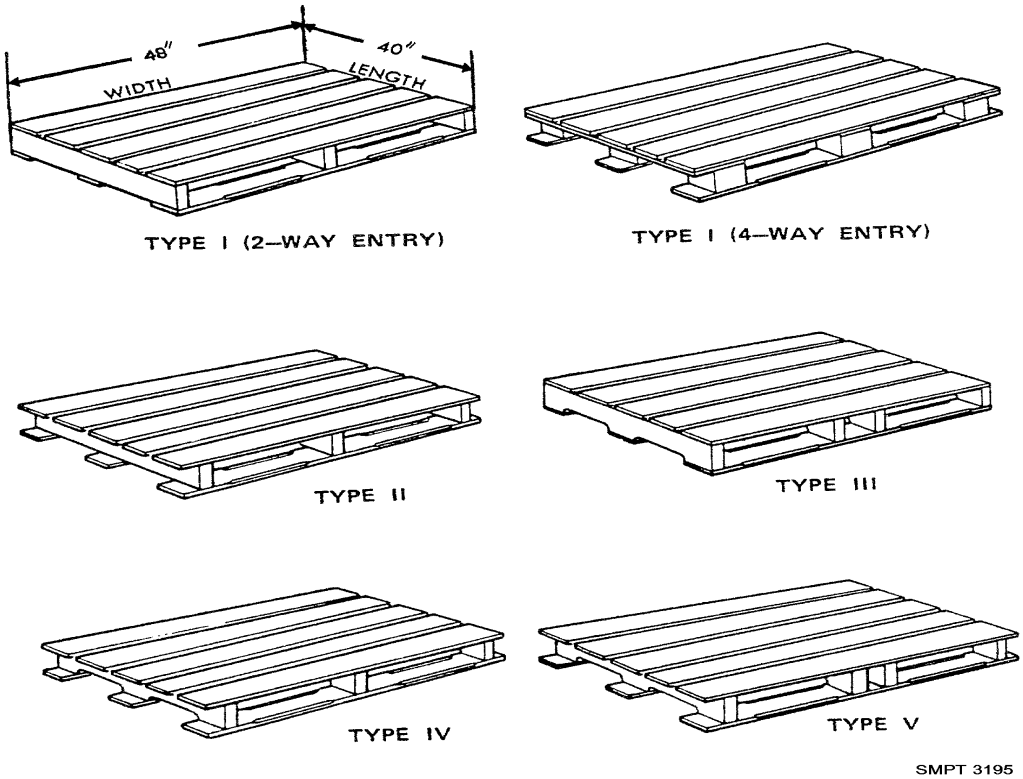


Figure 7-1. Advantages of cargo unitization.

- Reduces pilferage because of unitization of items by steel straps and other bonding methods.
- Permits faster movement of supplies and equipment. Reduces marking requirements on individual containers.

METHODS OF UNITIZATION

The two basic forms of unitization are--

- Palletization. Palletization is the placing of a number of packages on a low, portable platform constructed of wood, metal, or fiberboard, or a combination of these materials.
- Containerization. Containerization is the placment of a number of packages into a intermodal container, which not only reduces the number of units and documentation, but provides additional protection to the packages.

PALLETIZING UNIT LOADS (MIL-HDBK-774)

MIL-HDBK-774 gives the palletized unit load requirements for Department of Defense material using the pallets discussed in Chapter 3. The standard establishes loading patterns for various types of commodities, listing the pattern for stacking containers and the methods of unitizing to be used.

TYPES OF PALLETS

- NN-P-71. Types I (2-way entry), and III of NN-P-71 are intended for use in storage operations. Types IV and V of NN-P-71 are for use in storage and shipment worldwide regardless of mode of transportation.
- MIL-P-15011. Type I (4-way entry) of MIL-P-15011 should be used for the palletization of military supplies whenever 4-way entry is required in the storage and distribution system and in support of NATO forces. Nonstandard 4-way entry 40- by 48-inch pallets should be reused for the storage and shipment of materiel to CONUS consignees. (fig 7-2)

Limitations

The following size and weight limitations apply to the complete load including the pallet and the bonding and storage aids (fig 7-3).

Unless otherwise specified by the procuring activity, load units prepared for shipment in MILVANs and SEAVANs shall not exceed 40 inches in length. All other loads shall not exceed 43 inches in length, which permits an overhang of 1 1/2 inches at each end of the pallet.

Unless otherwise specified by the procuring activity, load units prepared for shipment in MILVANs and SEAVANs shall not exceed 48 inches in width. All other loads shall not exceed 52 inches in width, which permits an overhang of 2 inches at each side of the pallet.

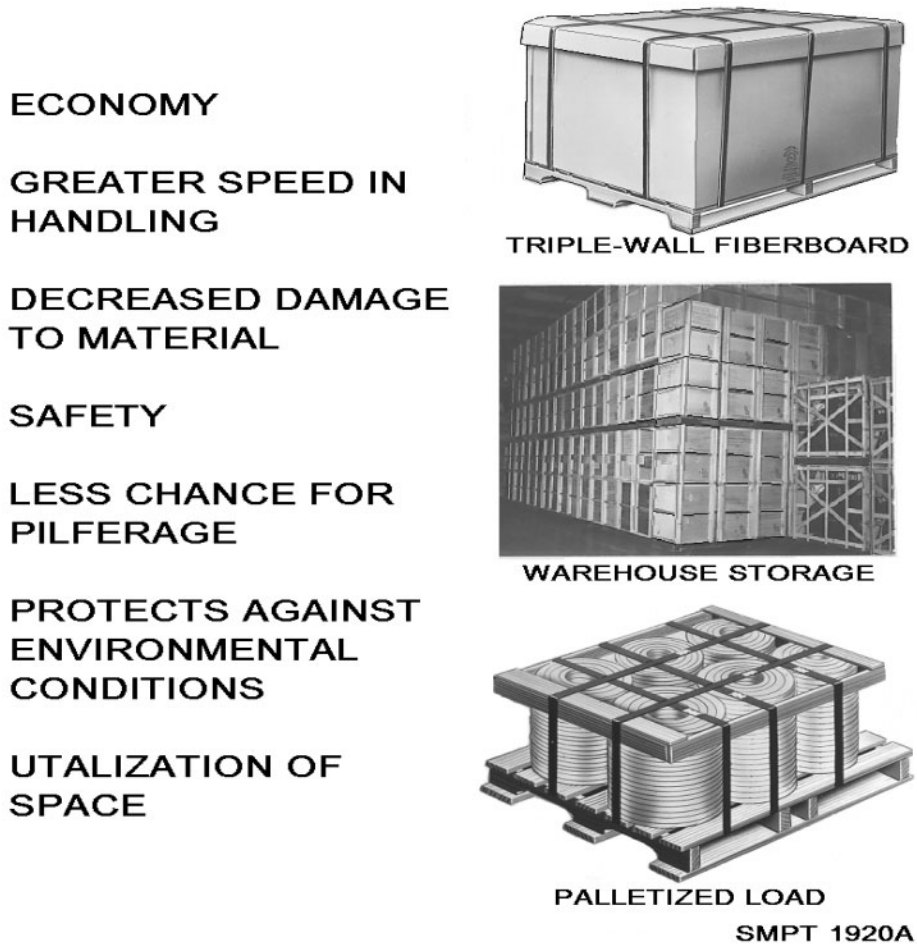


Figure 7-2. Types of pallets.

Load units prepared for shipment in containerization media such as SEAVANs, etc. shall not exceed 43 inches in height and in MILVANs, 41 inches. All other loads shall not exceed 54 inches in height, except as permitted for loads of compressed gases in cylinders.

The maximum gross weight of a load shall not exceed 3,000 pounds per single pallet load for domestic, intercoastal, or overseas shipments.

TYPES OF PALLETIZED LOADS

Types of supplies that can be palletized are--

- Items which are identical and identified by the same stock number.
- Items uneconomical or impractical to pack.
- Rugged and durable items that require minimum physical protection.
- Boxed items uniform in size requiring additional protection.
- Items that are moved in large quantities.

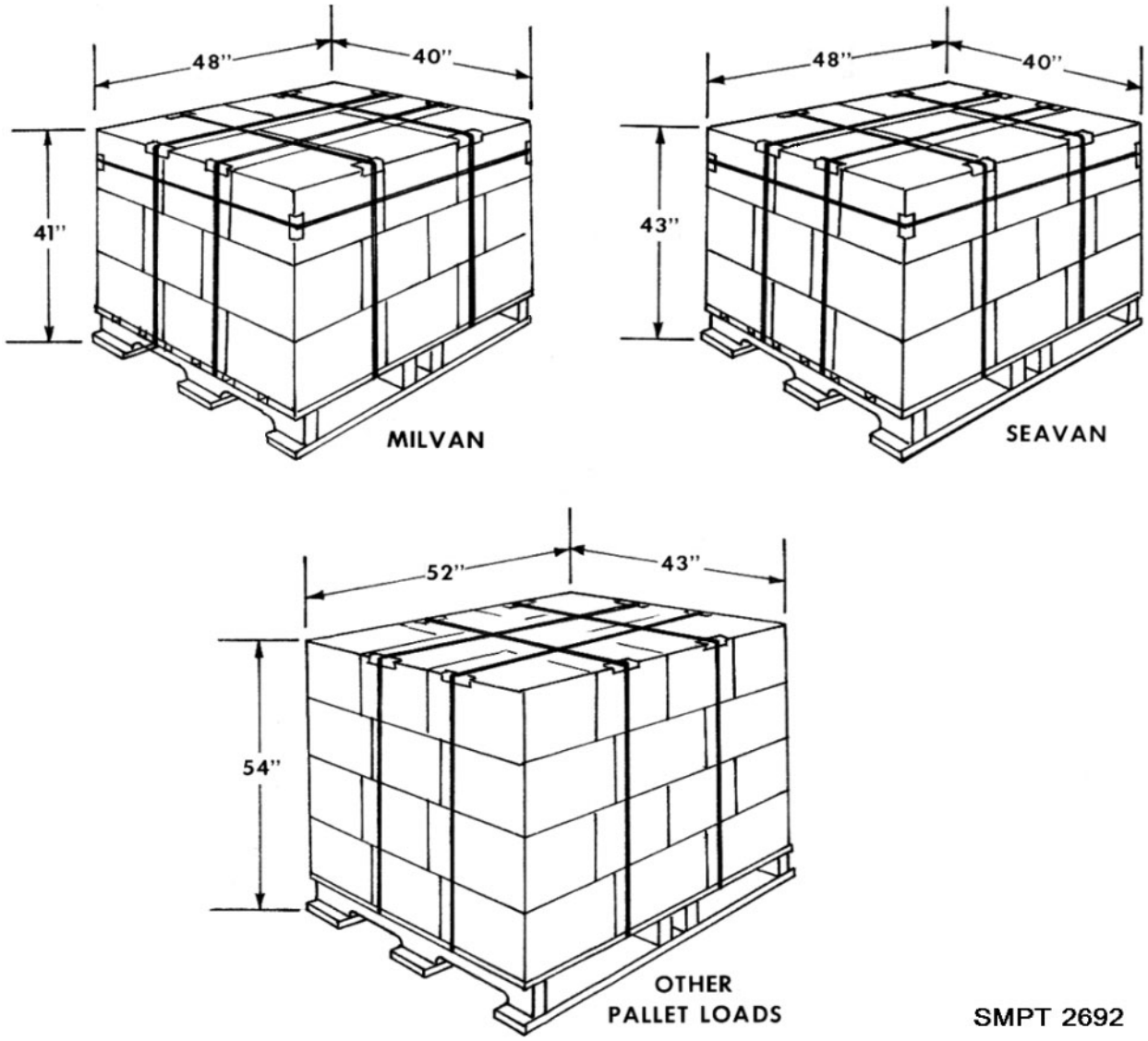


Figure 7-3. Pallet size limitations.

LOAD ARRANGEMENT

The arrangement of items to the pallet must provide a rigid, compact, uniform size load, strongly secured to prevent shifting, and capable of resisting impact, vibration, racking, and compression encountered during handling, storage, and shipment. Basic principles for arranging and securing loads to pallets are--

- Items should be interlocked, nested, or bundled whenever possible.
- The load pattern should eliminate or reduce void space.
- Wood separators or spacers are placed in voids between rows and layers of irregular-shaped items to insure a firm and stable load.

The top surface of the loading pallet must be level, or made level for stacking purposes. This can be accomplished by applying a wood top frame or leveling boards with a supporting framework.

Loads difficult to stabilize or which are compressible and not sufficiently firm to support superimposed loads, will be reinforced with a supporting framework.

Boxed items are arranged on the pallet so that the markings on individual containers do not show on two adjacent sides of the palletized load. This will provide clear areas for unit load marking.

The load is secured to the pallet, using ASTM D 3950 requirements for applying lengthwise and crosswise strapping. Horizontal strapping is the width and thickness size as the tie-down strap size. The gross weight of the load, divided by the total number of tie-down straps to be used, determines the weight which must be borne by each strap. Non-metallic strapping is not authorized for the strapping of palletized loads of wooden, plywood, or metal shipping containers.

Strapping is applied in a manner that will eliminate any possibility of slippage. Wood cleats, tie blocks, or braces are used under straps when necessary to insure stability or to bridge unsupported spans.

Loading

To properly load a pallet, consideration must be given to the type of item, its weight, and destination. It is recommended that MIL-HDBK-774 be followed when loading 40- by 48-inch pallets. Figure 7-4 shows one type of palletized load illustrated in the standard.

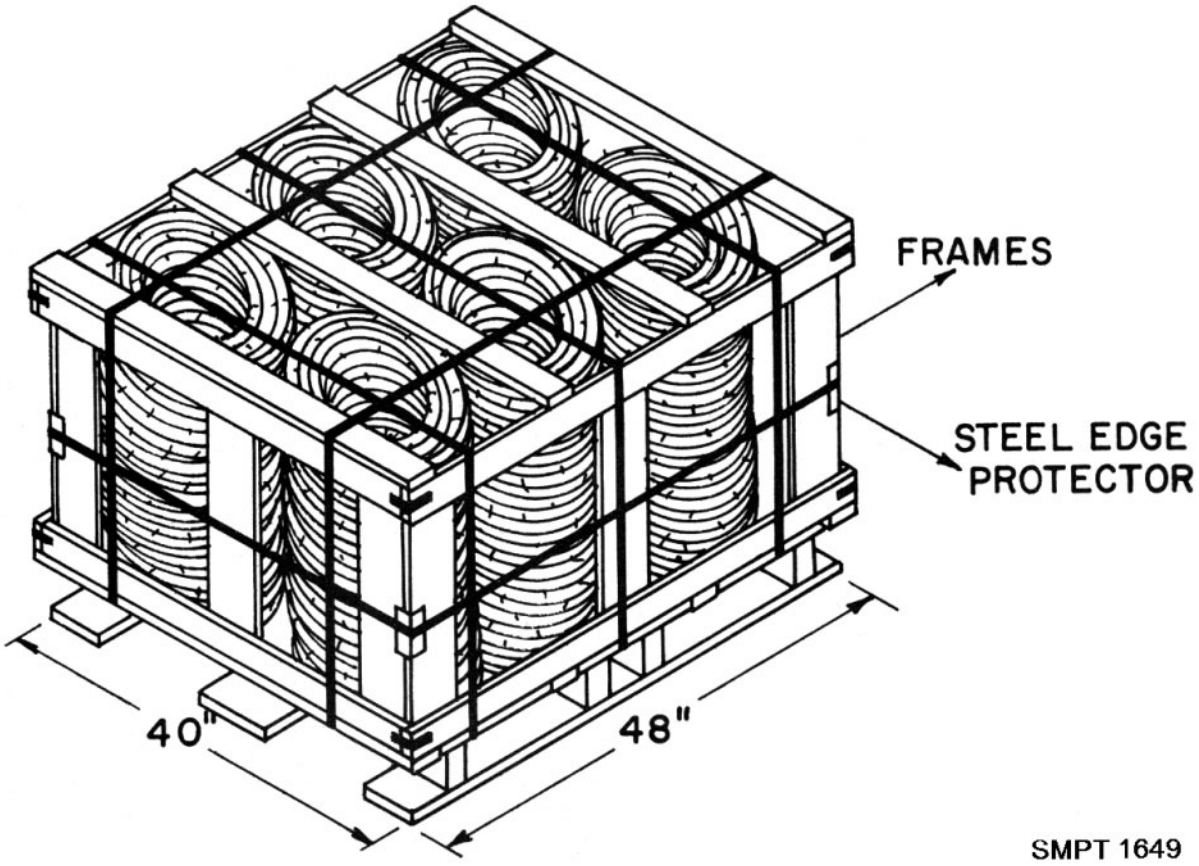


Figure 7-4. Examples of palletized load.

SHRINK FILM AND STRETCH FILM PALLETIZATION

SHRINK FILM

Plastic films such as polyethylene are now being used in accordance with the requirements of MIL-HDBK-774 as a means of bonding palletized loads. The plastic film is stretched in the manufacturing process; this is called "orientation". The stretched film shrinks when subjected to a controlled flow of heat air. The heated air is supplied by the use of a heat shrink cannon or a shrink film chamber (fig 7-5). The heat causes the film to shrink, conforming to the contour of the load. For this reason, it can be used for pallet loads containing a variety of items which form irregular shaped configurations that could not be palletized by conventional means. The tightly adhering film immobilizes the contents and provides stability. It also provides some weather protection for exposed cargo. Shrink film palletization provides a reduction of labor and material cost by the use of automatic equipment and eliminates the problem of damage caused by strapping containers too tight.

Stretch Film

Stretch films can be used as a means of bonding palletized loads for many commodities shipped in the Continental United States (CONUS) or when shipped containerized. The stretch films are polyethylene (PE), polyvinyl chloride (PVC) or ethyl vinyl acetate (EVA). The film is wrapped around the load in multiple layers from the top of the bottom deckboard to not less than two inches above the height of the load. The required thickness of the wrap is determined by the kind of film being used and the weight of the load. Additional bonding strength can be provided by placing a sheet of weather-resistant fiberboard, the same size as the top dimensions of the load, on top of the load prior to stretch wrapping.

CONSOLIDATION CONTAINERS (GENERAL)

Consolidation containers may be constructed of fiberboard, paper-overlaid veneer, plywood, or lumber. They may be demountable or non-demountable. They are usually secured to a pallet base or a skid base for handling purposes. Some containers are intended to be expendable, while others are intended to be reusable. Some consolidation containers are designed to be compatible with the requirements of the 463L Materials Handling System of the Air Force. Others are designed to be used as inserts in transporters such as MILVANs, SEAVANs, or to be used as separate shipping containers.

BOXES, SHIPPING INSERT CONSOLIDATION, MIL-B-43666 (GENERAL)

DESCRIPTION

These boxes are constructed of wood cleated plywood, plywood wirebound, double-wall fiberboard, or triple-wall fiberboard. They are mounted on pallet-type bases for ease of handling. Their construction varies widely depending upon the materials used. The sizes are such that they are modular in concept.

General Use

These boxes are intended for use as inserts in cargo transporters such as MILVANs, SEAVANs, or as separate exterior containers. They are to be used for Level A or B shipments.

Classification

There are three types of consolidation insert containers. Type I is of wood cleated plywood construction and has two styles depending upon the style of pallet base used. Type II is of plywood wirebound construction of the pallet base. Type III is constructed of double-wall or triple-wall fiberboard. Type III has four styles depending upon the construction features of the box.

Marking

The marking for shipment will be in accordance with MIL-STD-129.

Figure 7-5. Shrink film chamber used for heat shrinking film around palletized load.

TYPE I, WOOD CLEATED PLYWOOD CONSOLIDATION INSERT BOX (MIL-B-43666)

DESCRIPTION

These containers are wood cleated plywood boxes similar in construction to the PPP-B-601 cleated plywood boxes. They are provided with a four-way entry pallet base (fig 7-6).

USE

These boxes may carry Type 1, 2, or 3 loads not exceeding a density of 37 pounds per cubic foot. Loads exceeding this density require additional box reinforcement. They may be used for domestic and overseas shipments. They are intended for consolidation of like and unlike stock numbered items. These containers may be used as inserts in SEAVANs or MILVANs

SIZE AND WEIGHT LIMITATIONS

There are 15 sizes available in the wood cleated plywood consolidation insert containers. The outside length ranges from 29 to 86 inches. The outside width ranges from 31 3/4 to 45 inches. The outside height ranges from 20 to 52 1/2 inches. For MILVAN shipments, the overall height shall be not more than 41 inches. The weight capacity for the various sizes ranges from 1,000 to 2,600 pounds. Table I and II of MIL-B-43666 specifies the length, width, height, and weight combinations for each of the 15 sizes.

CLOSURE

Nail the top to the top cleats of the sides and ends using sixpenny cement-coated, chemically etched, or mechanically deformed nails spaced three inches apart. Do not drive the nails into the end grain of the vertical cleats.

STRAPPING REQUIREMENTS

Each vertical corner shall be reinforced with two 8-inch pieces of 3/4-inch flat steel strapping 0.023 inches thick. The strapping will be attached to the cleats with pneumatically driven galvanized staples 7/16 inches long or with 1-inch long nails pneumatically driven. As an alternate, 3/4-inch wide flat, nail-on strapping, 0.025 or 0.028-inch in thickness, may be used. This strapping, which is perforated with holes spaced 1/2 to 1 3/4 inches apart, may be secured with large headed galvanized roofing nails, zinc coated steel roofing nails, or 1-inch mechanically driven nails. Each strap will be secured with four fasteners. Two will be driven into the through cleat on the end of the box and two will be driven into the filler cleat on the side of the box.

- On boxes 41 inches high, strapping will be placed 13 to 26 inches from the top of the box.
- One boxes 20 inches high, strapping will be placed 2 and 15 inches from the top of the box.
- On box sizes 5 and 10, which are 43 inches wide, an additional strap shall be placed to the center of each corner formed by the bottom and end panels.

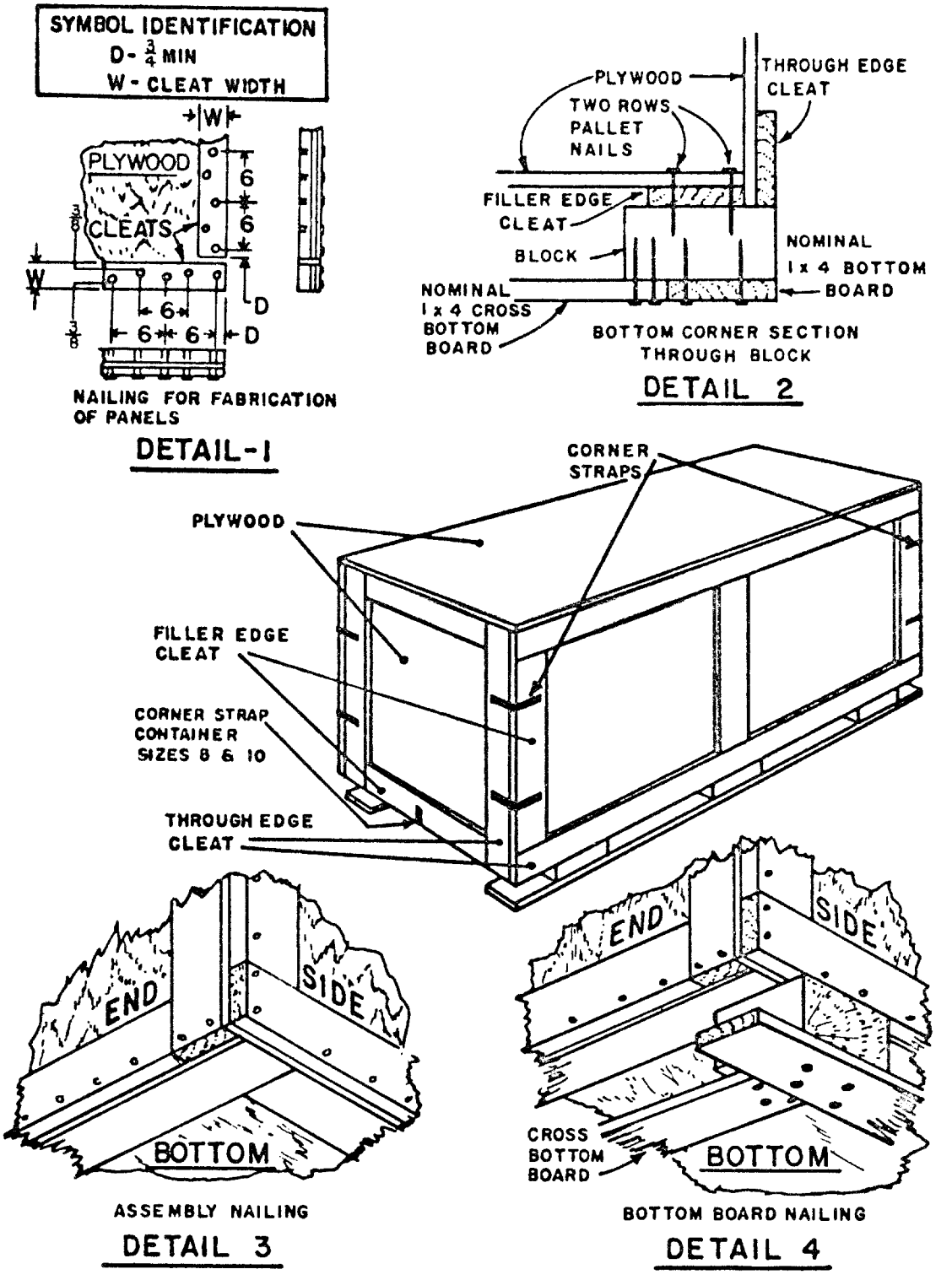


Figure 7-6. Type I, Style I, wood cleated plywood consolidation box (MIL-B-43666).

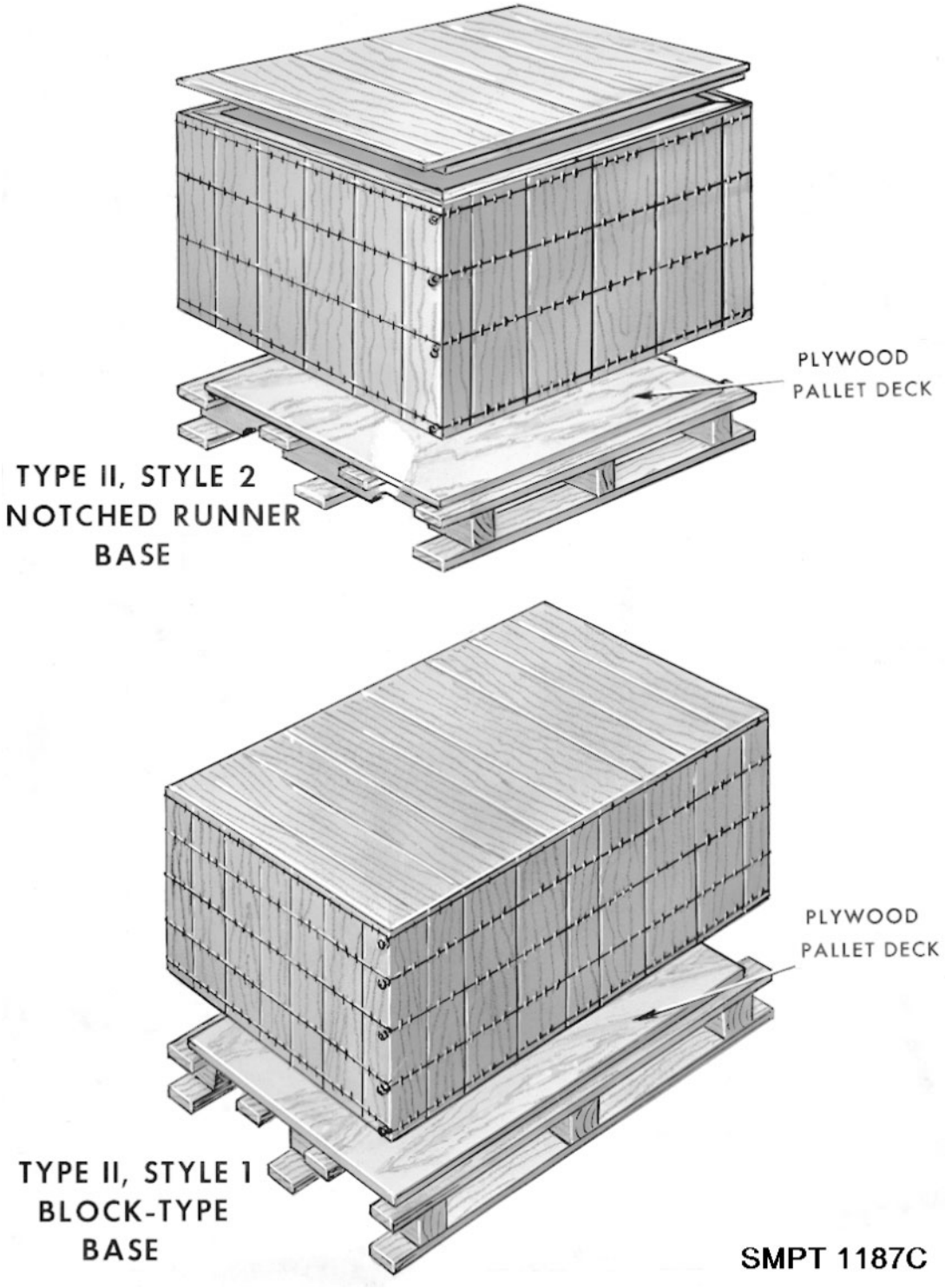


Figure 7-7. Type II, plywood wirebound consolidation boxes (MIL-B-43666).

TYPE II, PLYWOOD WIREBOUND CONSOLIDATION INSERT BOX (MIL-B-43666)

DESCRIPTION

The body and top of these boxes are constructed of plywood panels bound together with binding wires. The bottom panel is fabricated from 1/2-inch plywood which is secured to either a skid base or a pallet base (fig 7-7).

USE

The use of Type II plywood wirebound boxes is the same as Type I wood cleated plywood boxes.

CLASSIFICATION

There are two styles of boxes available under the Type II classification:

- Style 1 box utilizes a double-wing, block-type pallet base (fig 7-6).
- Style 2 box utilizes a skid base having three lengthwise skids which are cut out to facilitate side entry by forklift trucks.

Size and Weight Limitations

There are several sizes available in the plywood wirebound consolidation containers. The range of outside dimensions and weight limitations are the same as those specified for the Type I, cleated plywood boxes. Tables I, and II, of MIL-B-43666 specify the length, width, and height combinations for each of the sizes.

CLOSURE

After the box body is assembled by securing the wire loops with a sallee closure hand tool, or similar suitable alternate tool, and nailed to the base, make the closure by nailing the plywood top to the top cleats with threepenny nails. Space the nails 4 1/2 inches apart. Complete the closure by applying lengthwise and girthwise straps.

STRAPPING REQUIREMENTS

Requirements for the size, number, and location of straps vary for each style and size of Type II containers. Consult the Appendix of MIL-B-43666 for detailed requirements for reinforcing the particular plywood wirebound container being used.

TYPE III, FIBERBOARD CONSOLIDATION INSERT BOX (MIL-B-43666)

Description

These boxes are made of double-wall or triple-wall fiberboard. The box design and construction differs for each of the four designated styles. Unless otherwise specified, they are furnished with a pallet base.

USE

Type III fiberboard insert boxes should be restricted to MILVAN, or SEAVAN when used for level A overseas shipments. They may be used as shipping containers for Level B overseas shipments and as domestic consolidation containers. Style 3 should be used for items of assorted stock numbers to be loaded at origin as inserts only for shipment in MILVAN, and SEAVAN to a single consignee address code. Style 5 should be used for unit

loads of nonperishable subsistence as required by MIL-L-35078 and sized (in height) depending on the anticipated height of the contents.

CLASSIFICATION

There are four styles of boxes available under Type III classification:

- Style 3, regular slotted box (RSC), is the same as the alternate construction of the Style E ASTM D5168 fiberboard box with a 1 1/2-inch overlap of the outer flaps (fig 7-8). The box may be furnished with or without a pallet base. When a pallet base is used, it may be either a double-wing block-type or double-wing notched runner-type.
- Style 4 half slotted container (HSC) with telescoping sleeve and cap, consists of a half slotted container bottom section without top flaps, a sleeve (with stiffening flaps) which fits over the bottom section, and a top cap which extends down six inches over the sleeve (fig 7-8). The requirements for the pallet base are the same as for Style 1.

Style 5 flanged bottom tube with cap, pad, and pallet, consists of a fiberboard tube with 4-inch bottom flanges, a bottom pad, and a top cap which fits down over the body tube (fig 7-8). This type is furnished with a stringer type pallet base.
Style 6, half slotted container (HSC) with cap and pallet base, consists of a body having a regular slotted bottom and a flanged top, and a top cap (fig 7-9). Unless otherwise specified, it is furnished with a pallet base.

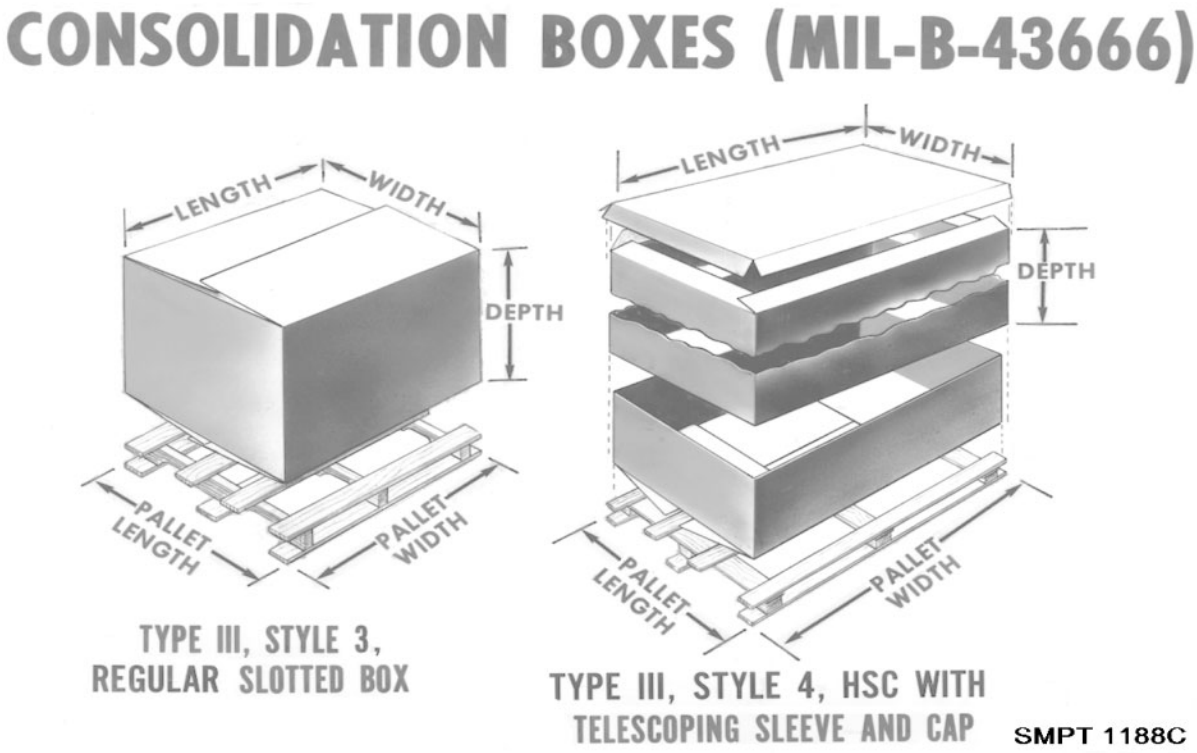


Figure 7-8. Type III, styles 3 and 4, fiberboard consolidation boxes (MIL-B-43666).

SIZE AND WEIGHT LIMITATIONS

There are several sizes available in the fiberboard consolidation containers, depending upon the styles. The outside length ranges from 29 to 86 inches. The outside width ranges from 31 3/4 to 42 inches. The outside height ranges for 20 to 52 1/8 inches. The weight limit ranges from 1,500 to 2,600 pounds. Style 3 is available in sizes 1 through 10; Style 4 is available in sizes 23 and 24; Style 5 is available in sizes 16, 17, 18, and 24; and Style 6 is available in sizes 14 and 15. Tables I and II of MIL-B-43666 must be consulted for the various length, width, height, and weight combinations of each of the sizes specified for Type III boxes.

CLOSURE

The closure requirements vary for each style of box. Type III boxes are constructed in accordance with Specifications ASTM D5168 and MIL-B-43666. The boxes are closed in accordance with the Appendix of the applicable specification.

STRAPPING REQUIREMENTS

Either metal or nonmetallic strapping may be used to reinforce Type III boxes. Requirements for the size, number, and location of straps vary for each style and size of box. Consult the Appendix of MIL-B-43666 for the detailed requirements for reinforcing the particular style and size of fiberboard consolidation box being used.

PACKING CONSOLIDATION CONTAINER

PROBLEMS INVOLVED IN CONSOLIDATION

The main problem involved in consolidation of materials becomes one of shock mitigation. The packer must be skilled in placing packages in the container so that each package "wedges in" other packages. The packer must be able to block or brace the load as he progresses, in a minimum of time and with the cheapest and lightest material, yet strong enough to do the job. Essentially, the problem becomes one of converting a type 3 load to a type 2 load for protection against shock and vibration.

SHOCK MITIGATION

In order to meet the problem of shock mitigation relative to consolidation containers, there are certain basic procedures to follow:

- Try to maintain level layers.
- Fill all internal voids as the load progresses.
- Keep the center of gravity low and centered by placing heavy items in the bottom portion of the container and centering them in the container as much as possible.
- Block and brace the interior load adequately to prevent movement caused by shock and vibration.

BLOCKING AND BRACING THE LOAD

The ideal conditions for full utilization of consolidation containers is to tailor a container to the size of uniform interior packages. Of course, the required consolidation containers are generally of standard dimension and are not related to product package sizes.

These ideal conditions are not always present at the depot or base level, but with a variety of package sizes to place in consolidation containers most of the available space can be utilized in some instances.

Voids that occur at the top of the pack are probably the most usual (fig 7-10). In order to provide holddown media for the load, first cover the packs with pad(s) and then place cells between the pads and the container cover. The use of adhesives will hold the cells between the pads and the container cover. Cells should be located where strapping will be placed. Where feasible, the corners of the container may be split down to the top of the load and the excess portion of each side panel, above the top of the load, may be folded in, thus eliminating the need for cells.

Voids that occur at the sides of the pack can be blocked with pads and cells, the same as top blocking and bracing (fig 7-11).

Interior voids (fig 7-12) are the hardest to cope with and the most time-consuming. All voids that would permit shifting of the packages should be filled with cells or foamed-in-place materials as the layers progress. If the packages are uniform, one sleeve may fill the void for several layers or packages.

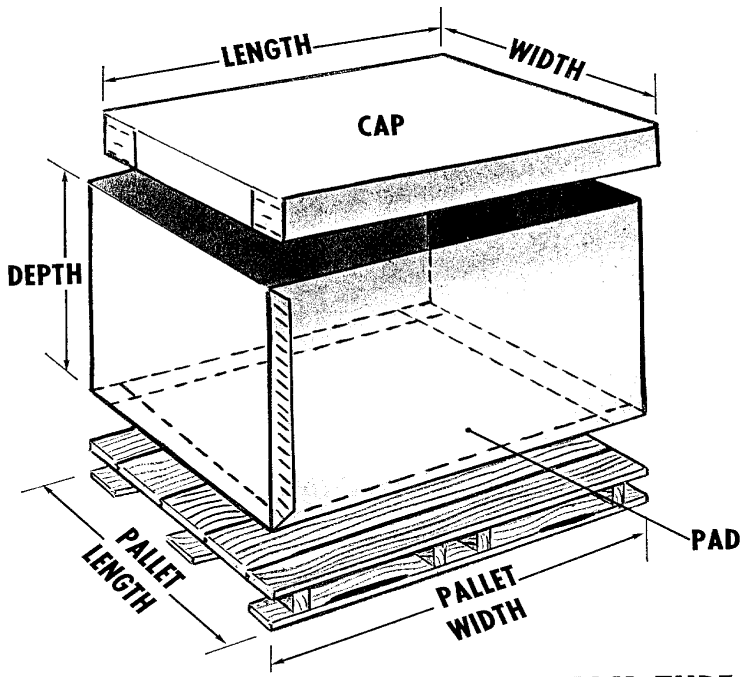
Compound voids (top and side, two sides, etc. may take a little more skill, but pads and cells can be used to block and brace the same as previously discussed.

PACKING SEMI-PERISHABLE SUBSISTENCE ITEMS

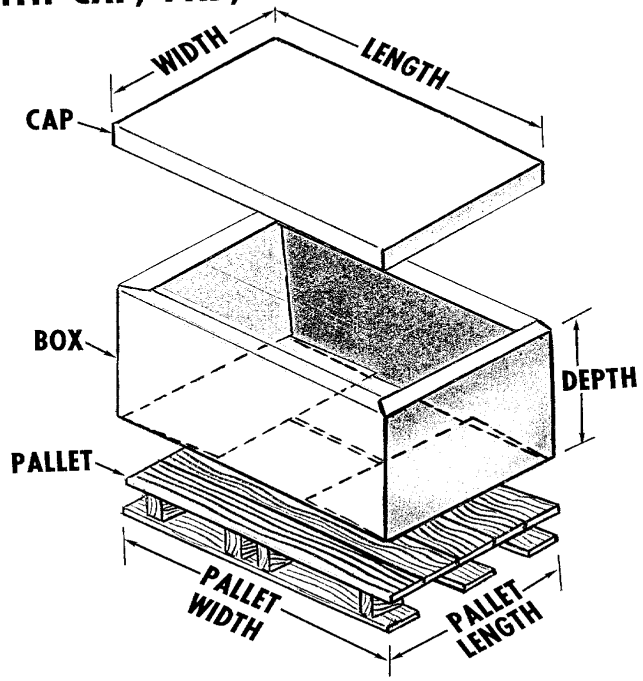
Unit loads of semi-perishable items shall be prepared in conformance with MIL-L-35078, Loads, Unit: Preparation of Semi-perishable Subsistence Items: Clothing, Personal Equipment, Equipage; General specification. This specification establishes patterns, methods, materials, and techniques applicable to the preparation of unit loads of nonperishable subsistence items by loading the shipping containers onto a pallet or within a consolidation container for shipment. The choice of unit load type and class based upon the level of protection provided can be determined from paragraph 6.1 of MIL-L-35078. Detailed specification sheets, MIL-L-35078/1 through MIL-L-35078/7, provide the requirements for each unit load type and class. The types and classes of unit loads are shown in table 7-1.

Table 7-1. Classification of unit loads of semiperishable subistence items (MIL-P-35078)

Types	Classes
I - Palletized unit load.....	A - Strapped or film bonded. B - Capped and strapped. C - Sheathed, capped and strapped. D - Shrouded, sheathed, capped and strapped.
II - Containerized unit load.....	E - Capped and strapped fiberboard box. F - Wood cleated or wirebound, strapped plywood box.
III - Commercial load base.....	G - Palletized. H - Load base.



TYPE III, STYLE 5, FLANGED BOTTOM TUBE WITH CAP, PAD, AND PALLET



TYPE III, STYLE 6, HALF SLOTTED CONTAINER WITH CAP AND PALLET BASE

SMPT 1879C

Figure 7-9. Blocking and bracing top voids.

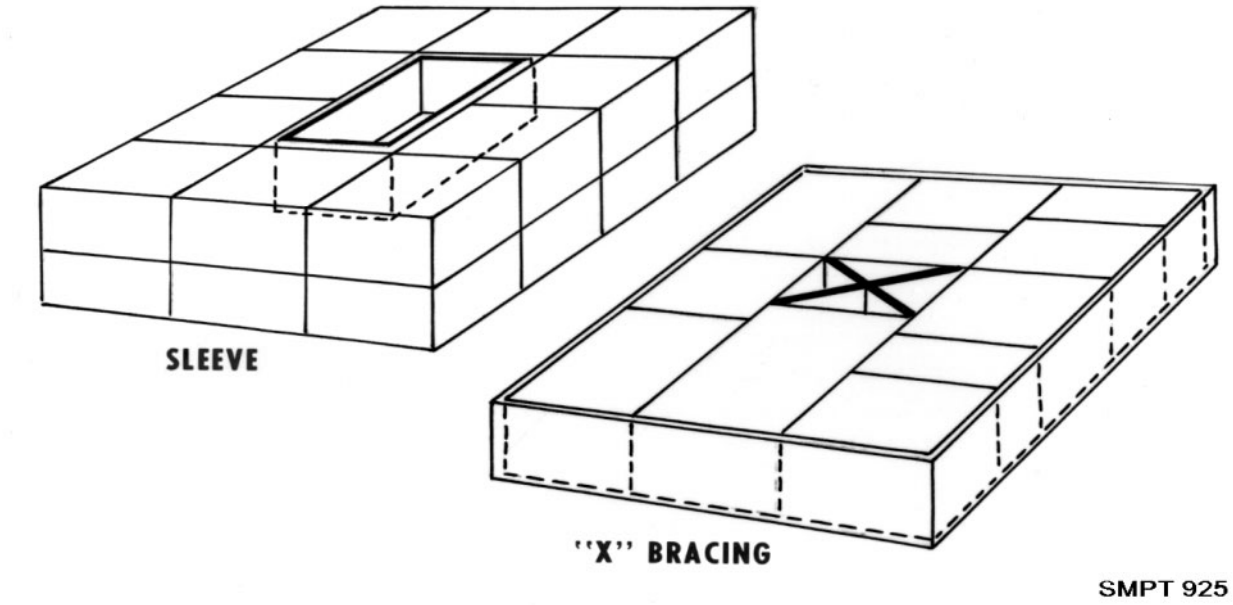


Figure 7-10. Sleeve and X bracing.

CARGO CONTAINERS (GENERAL)

DEFINITIONS

The following definitions apply:

Transporter - A cargo container is a large shipping container in which packed or unpacked material is placed for movement to a break-bulk point or to an ultimate consignee.

MILVAN - The MILVAN is a Government-owned or leased noncollapsible, reusable cargo container capable of being coupled to another container of like description. It can be lifted by top or bottom corner fittings; can be used either singly or coupled together; and can be carried by highway, rail or water modes of transportation.

SEAVAN - A SEAVAN is a privately-owned container of various sizes and configurations which may be leased to the Government for the consolidation movement of material by highway, rail or water modes of transportation.

Note - Cargo that is hard to handle in closed vans, such a large, heavy or bulky items, or machinery, may be shipped in flat racks.

AIR/LAND - The M2 AIR/LAND container is a lightweight intermodal container that permits land and air freight transportation without rehandling of the contents. The container is 8 feet in height, 8 feet in width, and 20 feet in length. They have a gross weight capacity of approximately 45,000 pounds. The container and its contents must not exceed the structural limitations of the transporting aircraft.

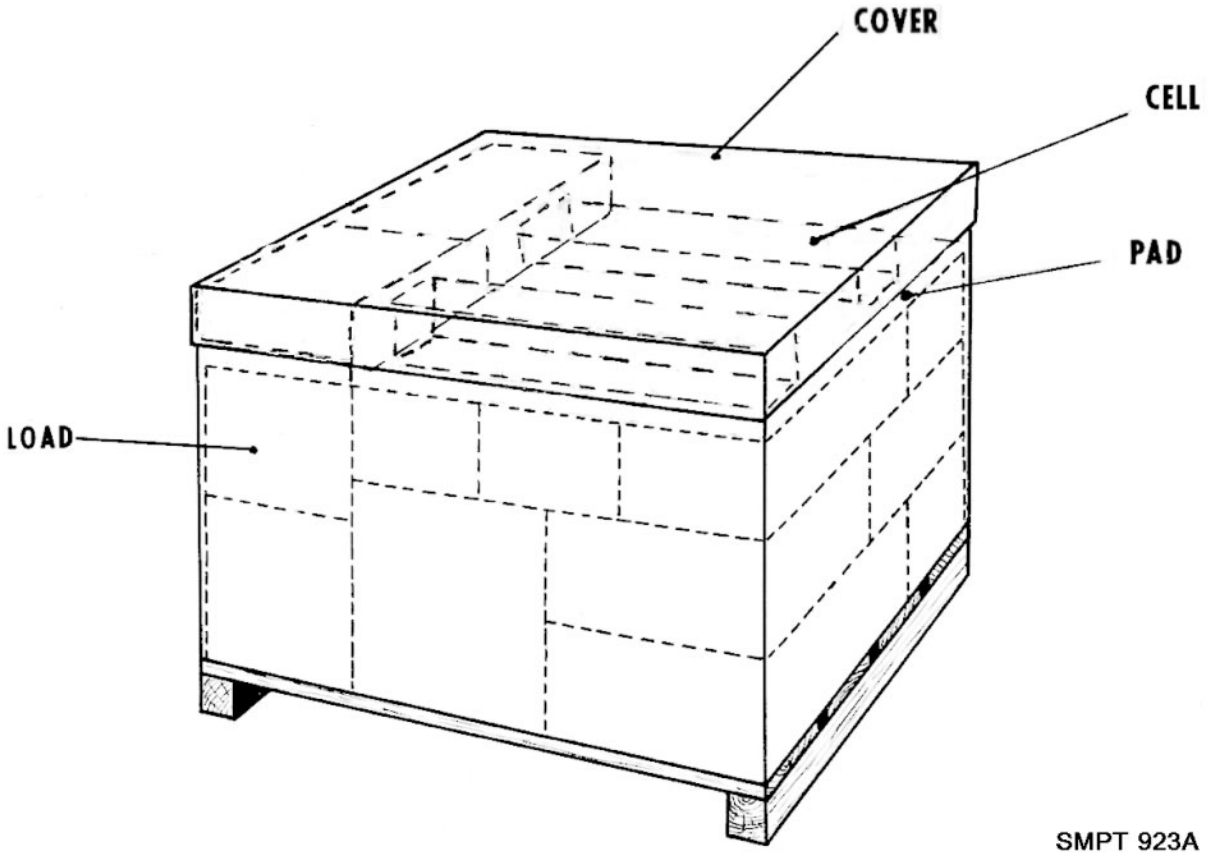


Figure 7-11. Blocking and bracing side voids.

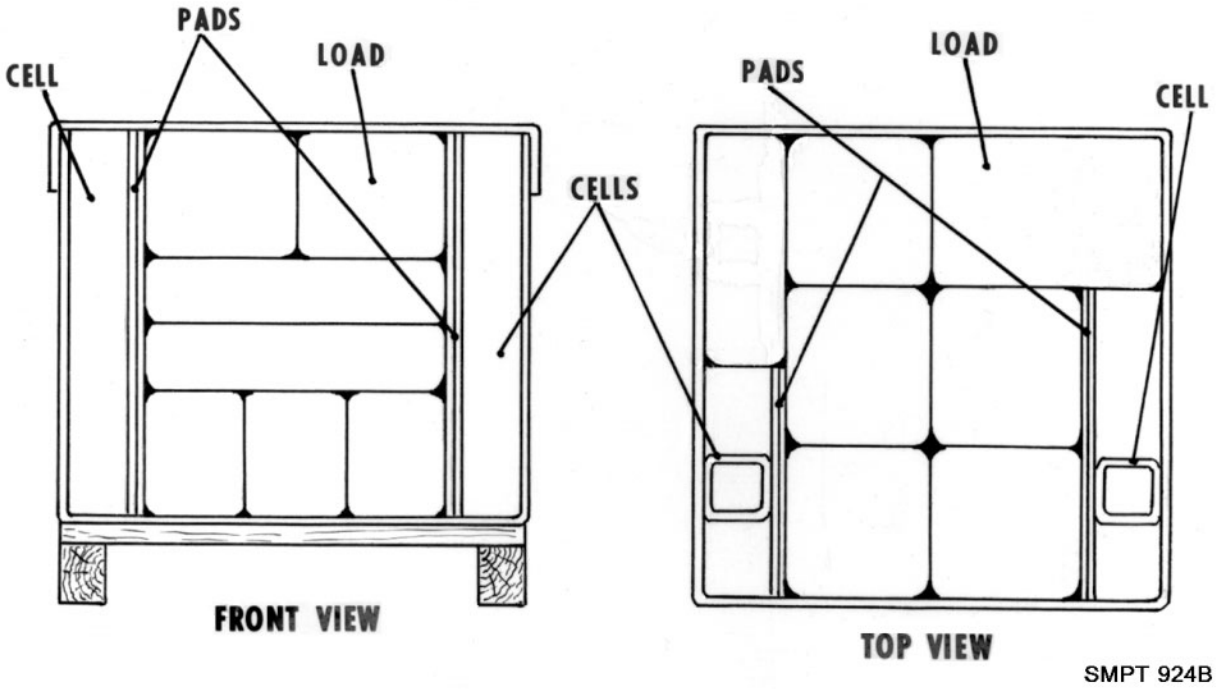


Figure 7-12. Blocking and bracing interior voids

Stuffing - The term "stuffing", as related to cargo containers, means the placing of cargo into cargo containers as distinguished from the process of loading containers on board ship. See MTMC Pamphlet No. 55-2 "Management and Stuffing of Containers".

PURPOSE AND ADVANTAGES OF LARGE CONTAINERS

Purpose

The purpose of cargo containers reduce the number of miscellaneous small package shipments to unit loads of the best possible size for the direct application of mechanical handling equipment.

Advantages

The use of mechanical handling procedures increases the speed, security, accuracy, flexibility, and economy of supply and transportation operations:

- Use of cargo containers reduces the cost of handling and rehandling many small packages.
- Loss due to damage to containers and supplies during handling and shipping is reduced.
- Loss due to pilferaging and misplacement or misrouting of individual packs is reduced.
- The consolidation of packs within cargo containers reduces the need for marking and documentation of individual packs destined for one consignee.
- Savings are realized through the elimination or reduction of heavy or expensive shipping containers.

USE OF MILVANS AND SEAVANS

DESCRIPTION OF MILVAN (MIL-C-52661)

A MILVAN has inside dimensions of 231 inches in length, 92 inches in width, and 87 inches in height. The gross weight rating for each 20-foot container is 44,800 pounds. A MILVAN can be coupled to another MILVAN container to make a single unit 40 feet in length. A MILVAN has the capability of being moved by semitrailer tractor when used in conjunction with a tandem bogie arrangement which serves as the rear wheels. When the double doors are properly closed, the MILVAN affords waterproof protection.

DESCRIPTION OF SEAVAN

SEAVANS vary from approximately 20 to 40 feet in length. The standard length utilized by the military is 40 feet. SEAVANs are 8 feet in height and 8 feet in width. They have a maximum gross weight capacity of 67,200 pounds. SEAVANs are compatible for movement by motor and rail and may be stored for shipment on specially containerized ships. They may be transported on a semitrailer chassis and are lifted easily and loaded, minus the chassis, on board by modern materials-handling equipment. There are four general types and three specialized types of SEAVANs:

Dry Cargo Container

The dry cargo container is weatherproof and is designed to protect the cargo from water. It is ideally suited for shipping items packed in domestic packs and any commodities susceptible to water damage. The dry cargo container is completely inclosed and must be loaded and unloaded by hand or forklift truck.

Dry Cargo--canvas Top Container

The canvas, or so-called "rag" top container, is similar to the dry cargo container, but has a removable canvas top. With the top removed, the cargo can be loaded and unloaded by crane as well as forklift. Canvas top containers are not 100 percent weatherproof; therefore, all items loaded in such containers must be in waterproof packs or otherwise be susceptible to water damage.

Flatrack Container

The flatrack container resembles a flatbed truck with varying styles of side bracing and corner posts and corner posts and comes in a variety of sizes. Generally, the flatrack has about two-thirds the cubic capacity of a dry cargo container, but with the same weight capacity. It is designed to carry high density and oddly shaped cargo that require little protection against the elements, although some are equipped with fabric covers. Brackets on the sides of the bed facilitate efficient tiedown or banding of heavy items to the bed of the container. Removable sides facilitate the loading and unloading by crane or forklift truck.

Reefer (Refrigerator) Container

Perishable cargo that must be refrigerated or frozen must be transported in a refer. Most of the commercial reefers have standard refrigeration units that are fuel operated for road use and electrically operated for storage or ocean transit. The standard container can refrigerate or freeze from ambient temperature to -10 degree Fahrenheit.

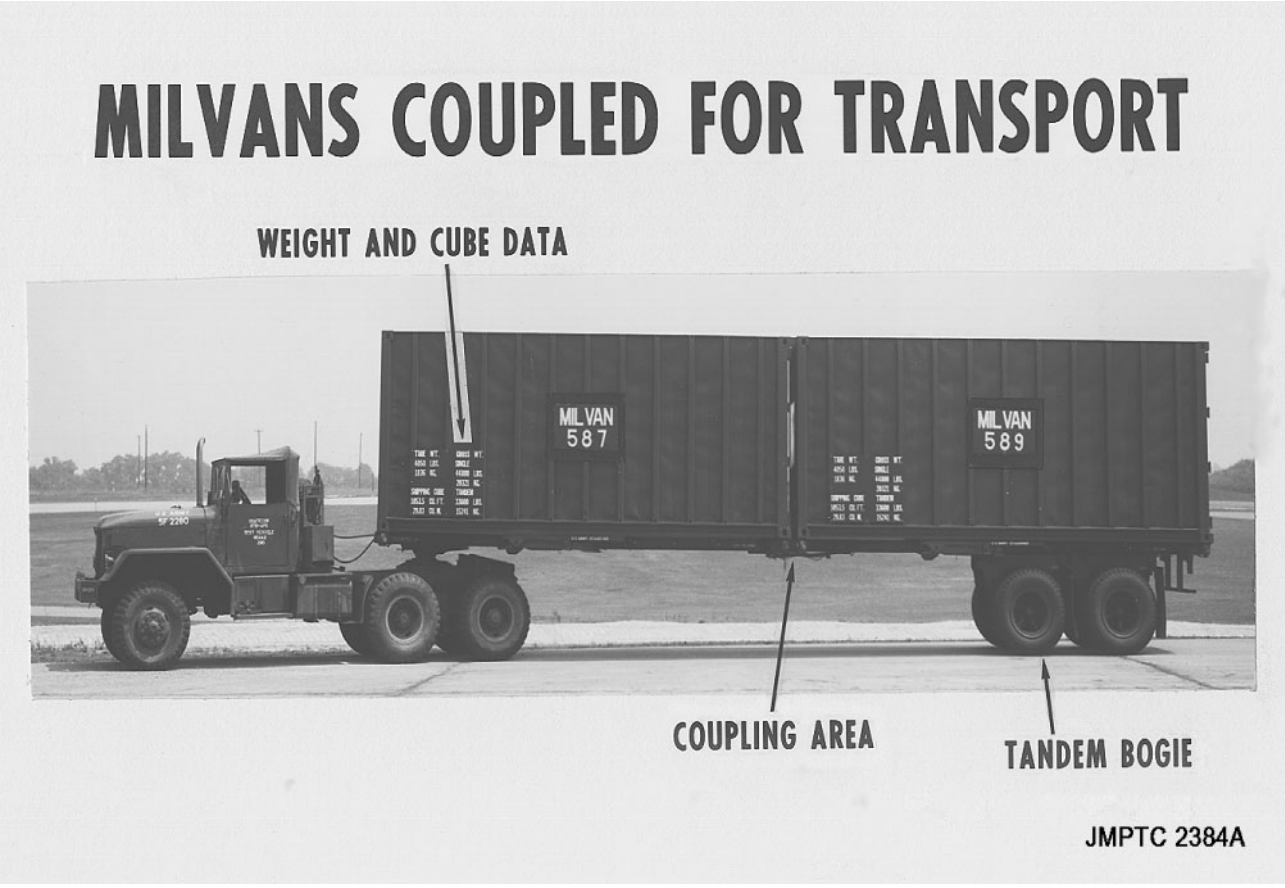


Figure 7-13 MILVAN cargo containers coupled for transport

Figure 7-14 SEAVAN loaded for highway movement

Insulated Container

This is a specialized container. It is used for cargo that should not be subjected to rapid temperature changes. It should be used when extreme changes in ambient temperatures are indicated.

Car-carrier

This specialized container is designed to carry two or four privately-owned vehicles for ocean transportation. The container which carries four vehicles is 35 feet long and has double-deck frames. Due to its additional height, the four vehicle container has one and one-half times the cube capacity of a dry cargo container.

Tank Container

This also is a specialized container. It is a small tank, inclosed in a framework, that can be used for small lot shipments of bulk liquids.

Weight Distribution

Distribute the load evenly throughout the container with heavier items on the bottom.

Cargo Must be Compatible With the Size of the Container

When the density of one commodity is not compatible with the container size, select an adequate commodity mix that will yield the best cube utilization. At least 80 percent of the cube should be used.

Weight Limitations

There are two overall transporter-weight: First, the rated capacity of MILVANs and SEAVANs; and second, the road-weight limitation imposed by the States over which the container must travel by motor vehicle.

SHIPMENT OF HAZARDOUS MATERIALS

Hazardous materials must be compatible with the remainder of the load. Do not stuff food or medical supplies in the same container as insecticides, chemical products, radioactive materials, biological materials, poisons, or toxic materials.

Do not ship noncompatible hazardous materials together.

Pack, mark, label, and placard hazardous materials in strict accordance with Department of Transportation and International Maritime Organization regulations.

The U. S. Coast Guard regulations prohibit certain explosives and other hazardous materials from being shipped in cargo containers.

GENERAL RULES FOR STUFFING MILVANS AND SEAVANS

The general rules discussed below concern the stuffing of general cargo into MILVANs and dry cargo type SEAVANs.

Place heavy items on the bottom of the load, maintaining an even distribution of weight throughout the cargo container.

When stuffing standard 43-inch high modular containers, double-tier them whenever possible. If double-tiering is not possible, top off the load with "fluff cargo" of low density. "Fluff cargo", which must be man-handled, should not exceed 200 pounds per item or pack.

Leave several inches of head space between the top of the load and the top of the cargo container so that the load can be removed easily with a forklift truck.

Pack the load as tightly as practicable. Do not wedge the load or pack it so tightly that problems will occur during unstuffing operations.

Always position palletized or skidded loads to rest on their pallets or skids. Face pallet access slots toward the doors to minimize forklift maneuvering during unstuffing operations.

Never place a heavy crate or box so that it rests on top of, and inside the four corners of the box beneath it. Place dunnage over the lower level of containers when dense loads in the upper tier may cause damage to the containers below.

Place boxes, crates, and cartons, which contain liquids that may leak, on the bottom of the load whenever practicable.

Keep drums that contain petroleum products separated from general cargo. Stow drums with their bungs on top. Pack the drums tightly. When possible, pelletize drums. When not palletized, place strips of dunnage between tiers of drums. Use lumber, burlap, fiberboard or paper, as applicable, to prevent it from shifting during transit. Use dunnage when it is available for filling spacing between large boxes or crates.

A load checker should keep a running account of the weight of individual items being stuffed to ensure the correct total net weight. Enter the overall load weight and cube on the loading list or the Transportation Control Movement Document (TCMD). Brace cargo of average or high density to prevent it from falling out when the container doors are opened.

Closing and Sealing MILVANs and SEAVANs

Place the shipping documents in the space provided on the door. Make sure that both rear doors on MILVANs and SEAVANs are closed by sliding the closure bolts into the holes provided in the body of the cargo containers. Position the door handles over the latches in the doors and attach a numbered railway car seal. MILVANs require that both door latches are provided with a seal.

Make sure that the serial numbers on the seals correspond with the numbers on the shipping documents. Thread the seals through the latches on the doors and snap the seals into the seal locking devices. Use padlocks of approved design on cargo container containing classified material. Be sure that key control measures are provided.

Marking of MILVANs and SEAVANs

Shipment units and shipment units in consolidation will be address marked in accordance with Military Standard MIL-STD-129, Standard Practice for Military Marking. The address markings for MILVANs and SEAVANs shall be accomplished by attaching a waterproofed Military Shipping Label (DD Form 1387) adjacent to the seal, if required, or at the rear of the van. Data for the label will be in conformance with DOD 4500.32R, Military Standard Transportation and Movement Procedures (MILSTAMP) and MIL-STD-129.

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By Order of the Secretary of the Army:

Official:

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General, United States Army
Chief of Staff

JOEL B. HUDSON
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